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Highlights Report Fiscal Year 1999

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INTRODUCTION

National Wildlife Research Center—Mission and Location

The mission of the U.S. Department of Agriculture's (USDA) Wildlife Services (WS) program is to provide Federal leadership in managing problems caused by wildlife. The National Wildlife Research Center (NWRC) functions as the research arm of WS by providing scientific information on the development of socially acceptable methods for wildlife damage management. As part of WS' strategic plan to improve the coexistence of people and wildlife, it has identified four goals: (1) developing methods, (2) providing wildlife services, (3) valuing and investing in people, and (4) enhancing information and communication. WS is dedicated to helping meet the wildlife damage-management needs of the United States by building on the unit's strengths in these four key areas. This annual report, like the research it documents, is structured around these program goals.

Dedication of Wildlife Science Building

In January 1999, NWRC staff in Fort Collins, CO, moved from three temporary buildings into a new headquarters laboratory and office building, the NWRC Wildlife Science Building, located on 43 acres on the Foothills Research Campus of Colorado State University (CSU). The new building houses all NWRC staff in Fort Collins except for the Animal Care staff, who are located in the adjacent NWRC Animal Research Building (ARB). The Wildlife Science Building was financed and constructed by a private developer and is leased to the U.S. Government. The building comprises 82,000 ft^2 of space, including specialized laboratories for bird, mammal, product development, and chemistry research along with other unique spaces for the research library, record and tissue archives, conference center, and office space for 100 NWRC staff, visiting scientists, and students.

The next phase of the NWRC master plan for this site is under way. It includes construction of outdoor animal research facilities and the ARB support wing. These facilities should be completed by the year 2001. Some additional construction will still be needed to complete the master plan.

On April 16, 1999, NWRC's new Wildlife Science Building was dedicated by Deputy Secretary of Agriculture Richard Rominger. Under Secretary of Agriculture Mike Dunn, then-WS Deputy Administrator Bobby Acord, U.S. Congressman Bob Schaffer, CSU President Albert Yates, and General Services Administration Regional Administrator Polly Baca also spoke. Many of the 150 guests attending the dedication toured the new building and the ARB to learn about the Center's diverse research efforts to address wildlife damage issues. It was an historic day for USDA, APHIS, WS, and the NWRC.

Construction of the Wildlife Science Building is a remarkable APHIS accomplishment toward achieving the goals of the WS–NWRC master plan. Upon completion of the master plan, the NWRC, with its regionally based field stations, will be the only wildlife research complex of its kind in the world devoted entirely to providing technological information and new science-based solutions for wildlife damage and associated human safety problems.

DEVELOPING METHODS

Goal: Increase effective methods available for wildlife damage management.

The NWRC conducts focused, applied research through a multiyear project-management system that addresses the priority research needs identified in a 1996 WS research needs assessment. During fiscal year (FY) 1999, 11 of the Center's 16 research projects were due to end. As a result, NWRC sponsored external reviews of these projects. These reviews brought together WS research and operations personnel, other State and Federal researchers and managers, stakeholders, and private industry to review the success of each project and provide recommendations for future research directions. As a result of these evaluations, NWRC will begin 11 new projects in FY 2000 (mostly on the same general topics) but with new goals and objectives. However, two projects are addressing completely new areas of research for NWRC: vulture impacts on livestock production and zoonotic diseases related to waterfowl fecal matter in urban and agricultural landscapes. Both topics were identified by the WS program as critical. These 11 new research efforts will increase the Center's FY 2000 project total to 18.

BIRD RESEARCH PROGRAM

Title: Management Strategies to Reduce Bird Problems in the Western United States

Goal: Develop safe and effective methods to reduce bird problems in the Western United States.

New Bird Repellant Shows Promise for Reducing Horned Lark Damage to Sprouting Lettuce—Bird damage to sprouting vegetable crops is a major problem in California. Producers in the San Joaquin Valley, the central coast, and southern California report annual losses of about $4.6 million due to bird damage to sprouting lettuce seedlings. Horned larks, the species responsible for most bird damage to sprouting crops, cause damage by nipping off parts of seedlings or pulling out entire plants. NWRC scientists evaluated Flight Control,™ a 50-percent anthraquinone product that shows promise as a bird repellant for protecting lettuce seedlings from bird damage. In two exploratory field trials under controlled

conditions, NWRC scientists examined the effectiveness of Flight Control at foliar application rates of 5 and 10 L/ha to reduce horned lark damage to sprouting lettuce seedlings. Horned larks damaged about 60 percent of lettuce seedlings treated at the lower application rate but only 8 percent treated at the higher rate. Future tests will evaluate this product for protecting seedlings in commercial lettuce fields.

Silt Fencing and Egg Addling Reduce Threat of Gull Predation on Endangered Salmon Smolts—Island breeding populations of gulls and terns have been implicated in depredations to migrating endangered salmon smolts along the Columbia River in Washington. One colony of 8,000 ring-billed gulls on Cabin Island is estimated to have consumed more than 4.2 million salmon smolts during the peak nest period. Similarly, 15,000 Caspian terns on Rice Island took as many as 25 million endangered salmon smolts, or 25 percent of the released salmon population. NWRC scientists evaluated egg addling and silt fencing for reducing breeding populations of gulls near salmon migration areas. The use of corn oil to addle eggs in a ring-billed gull colony on Cabin Island that originally housed 8,000 birds reduced the number of nesting gulls by 99 percent (or complete abandonment) after year 5. Silt fencing, a woven black polypropylene material placed in parallel rows spaced 5 m apart, also discouraged gulls from nesting on islands and impeded populations from foraging along the dam face, where salmon smolts congregate and are most vulnerable. In a field trial on Upper Nelson Island, silt fencing reduced nesting by ring-billed gulls by 84 percent. Fencing 10 of 11 acres of a 15,000-bird Caspian tern nesting colony on Rice Island caused a reduction in nesting and consolidated the remaining nests into the acre that was not fenced. Some terns (1,200) dispersed to another island. NWRC scientists plan to conduct additional tests to evaluate silt fencing for protecting endangered anadromous fish from bird predation.

Nighthawks Present Unique Problems for Aircraft at McConnell Air Force Base—Bird strikes to aircraft are an increasing threat at McConnell Air Force Base (AFB) in Wichita, KS. Several strikes have been reported since 1994, and in the last 3 years birds have caused severe damage to aircraft. Of the birds struck, 82 percent are common nighthawks. NWRC scientists are monitoring birds on the base to determine when and where birds pose the biggest danger. Results indicate that common nighthawks are present on McConnell AFB only during the fall migration, from September through October. They begin using the airfield between 6 and 8 p.m. and continue until about 2 a.m., and peak numbers occur between 10 p.m. and 2 a.m. Nighthawks use three primary roosting sites on the airfield: runways, an infield road, and an overrun area at the end of one runway. Observations indicate that nighthawks use the airfield for roosting but not foraging. Studies of nighthawk food habits indicated that corn earworm moths represent about half of their diet.

Because nighthawks use the airfield during nighttime hours, management of the species is difficult. Commonly used hazing techniques are not practical and sometimes require the use of night vision equipment. Current research is evaluating capturing and translocating of nighthawks away from the base to reduce aircraft strikes. During September 1999, 121 nighthawks were captured, translocated, and released 25 or 50 miles from McConnell AFB. None of these nighthawks returned to the airbase, and the number of strikes was reduced over 90 percent during this period.

Title: Development of Management Strategies To Reduce Piscivorous Bird Predation at Aquaculture Facilities

Goal: Determine the magnitude of, and develop methodology to reduce, bird predation on cultured aquaculture products, including catfish, baitfish, tropical fish, trout, and other finfishes.

Impact of Wading Birds on the Catfish Industry—Wading birds, primarily great blue herons and great egrets, are ubiquitous avian predators on commercial catfish farms throughout the year and are perceived to be a major constraint on production. Surveys of these birds have shown that their populations have increased by at least threefold in the past 5 years. During a yearlong field investigation, populations of both herons and egrets at randomly selected catfish farms in the delta region of Mississippi fluctuated seasonally and peaked in the fall. Both species occurred on catfish farms in similar numbers, but their diets were quite different. Live catfish made up only 8 percent of the diet of great egrets but 44 percent of the diet of great blue herons. Both species consumed live catfish mainly in the spring and fall, when catfish diseases are most prevalent. During captive heron foraging studies, heron predation had a negligible impact on catfish populations, and herons were able to maintain their body weights only when "diseased" catfish or sunfish (a noncommercial species found in many commercial ponds) were present in the ponds; these herons apparently could not capture healthy catfish. The researchers concluded that herons were inefficient foragers on healthy catfish. A subsequent field study confirmed that most live catfish captured by herons from commercial catfish farms are diseased. Birds also capture live catfish that come to the surface to obtain floating fish feed.

NWRC biologists also investigated the role of great blue herons as a vector of catfish diseases. In a cooperative study with the Mississippi State College of Veterinary Medicine, herons were repeatedly fed captive catfish that contained exaggerated levels of the organism causing enteric septicemia, one of the most economically significant catfish diseases. Researchers collected, cultured, and examined fecal and feather samples as well as throat and rectal swabs daily from birds but did not detect any viable pathogens. The high body temperature of herons presumably suppressed growth of the enteric septicemia organism. These findings indicate that wading birds are not significant vectors of this disease.

Managing Cormorant Depredations—Double-crested cormorants are the most important avian predator affecting the catfish industry. In the delta region of Mississippi, where most of the catfish industry is concentrated, in excess of 60,000 wintering cormorants are estimated to consume $4 million worth of catfish annually. NWRC scientists demonstrated that coordinated and simultaneous harassment of cormorants in night roosts can shift roosting populations away from catfish farming areas to the Mississippi River, where birds are more likely to forage in natural waterways. NWRC scientists conducted a radiotelemetry study to monitor the effects of an operational roost-dispersal program on the movements of cormorants in

the delta. The results of this study confirmed that cormorants dispersed from catfish-growing areas to roosts along the Mississippi River do not return to the former area. Similar results were obtained in another cormorant telemetry study conducted in Alabama.

One of the limitations to cormorant roost dispersal is that the use of pyrotechnics might also disperse waterfowl and other wildlife from these sites. To help alleviate this problem, NWRC biologists are investigating a low-powered laser device for selectively dispersing cormorants without disturbing other wildlife.

In addition to cormorant roost dispersal, a recent standing depredation order issued by the U.S. Department of the Interior's U.S. Fish and Wildlife Service (FWS) allows catfish farmers to achieve localized population control by shooting cormorants on their ponds. To enhance the cormorant roost-dispersal program and possibly to expand the localized cormorant control under the current standing depredation order from ponds to roosts, NWRC biologists initiated a cooperative study with APHIS' Wildlife Services office in Mississippi to compare the effectiveness of pyrotechnics versus shooting for dispersing cormorant roosts. Results indicate that both shooting less and pyrotechnics are effective for dispersing an entire roost.

Aquaculture and American White Pelicans—American white pelicans are an increasing problem at commercial aquaculture facilities in the Southeastern United States. As many as 1,000 pelicans frequently feed on a single pond, and each pelican eats 1–3 pounds of fish per day. NWRC biologists are monitoring the movements of pelicans equipped with satellite transmitters to learn more about habitat relationships, regional and migratory movements, and impacts on the aquaculture industry. Scientists have been conducting aerial surveys of pelicans since December 1997 to determine winter population trends and habitat preferences in the delta region of Mississippi and southern Louisiana. Investigators are also analyzing recovery records of pelicans banded at a colony at Marsh Lake, MN, between 1972 and 1999 to determine migration and dispersal patterns. Pelicans from this colony migrate through the Great Plains and along the Mississippi River to spend the winter in the lower Mississippi River Valley and along the Gulf of Mexico. Prior to 1985, only 5 percent of birds banded at Marsh Lake were recovered in areas that are now aquaculture-intensive sites. Since 1985, the number of birds banded at Marsh Lake and recovered near Southeastern aquaculture areas have increased to more than 21 percent of winter recoveries, indicating that aquaculture provides an important food source for wintering and migrating pelicans. In addition, 95 percent of the prey items identified in the stomach contents of pelicans collected near aquaculture facilities in the delta region of Mississippi and southern Louisiana were catfish.

Title: Management of Wildlife that Pose Hazards to Aviation

Goal: Develop safe and effective methods for reducing wildlife hazards to the air transport industry.

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75–90 Percent at John F. Kennedy International Airport (JFKIA), 1991–98—In 1999, the WS program successfully completed its ninth year of assistance to the Port Authority of New York and New Jersey at JFKIA. This program has annually reduced gull collisions with aircraft by 75 to 90 percent compared with the baseline years 1988–90. In this joint operational and research program, biologists have removed more than 50,000 laughing gulls and 5,000 other gulls at the airport. During this time, the nearby nesting ce land that is the source of the bird strike problem has declined by only about 30 percent, from 7,600 nests in 1990 to 5,450 nests in 1998. An analysis of data from leg bands recovered from 602 gulls at JFKIA indicated that many gulls hatched in colonies in New Jersey 60 miles or more from JFKIA have immigrated to the colony next to the airport to nest as adults. Because many Atlantic-coast colonies of laughing gulls have been increasing, a large cohort of birds has been available to replace birds removed at JFKIA. Therefore, an annual shooting program at JFKIA, although effective in reducing the number of gull–aircraft collisions, has not eliminated the nearby nesting colony or caused a decline in the regional breeding population.

A possible effective long-term alternative to shooting would combine a program of harassment, habitat alteration, and/or nest destruction at the colony site to relocate the colony away from the airport. However, a relocation program has not been possible because the nesting colony resides on a fully protected wildlife refuge.

Anthraquinone-Based Bird Repellant, Flight Control, Registered as Grazing Repellant for Canada Geese—In 1997, scientists at the NWRC's Sandusky, OH, field station evaluated the effectiveness of Flight Control as a grazing repellant for Canada geese in pen tests in northern Ohio. In all replications, there was greater goose activity on untreated plots compared with treated plots over a 7-day period. In 1998, scientists conducted three additional experiments to test the hypothesis that adding a plant-growth regulator to the formulation would enhance the repellancy of the product by minimizing growth of untreated grass after application. The first experiment determined that grass height did not influence goose presence or grazing. The second experiment determined that application of the plant-growth regulator, although it significantly reduced the growth and height of grass compared with untreated plots, did not reduce goose presence or grazing. However, in the final experiment, in which Flight Control and the growth regulator were both applied in a mixture, an 88-percent reduction in grazing in treated plots compared with untreated plots was recorded over a 22-day period.

The most impressive feature of this product was the fact that repellancy showed no signs of abating at the end of the 22-day experiment. The scientists concluded that the plant-growth regulator provided a very positive synergistic effect in enhancing the repellancy of Flight Control as a grazing repellant for Canada geese. In addition, the plant-growth regulator provided the added benefit of reducing the need for mowing. These experiments indicated that Flight Control, alone or in combination with a plant-growth regulator, will be useful as part of an integrated management plan to minimize goose presence on airports and at other locations where geese conflict with human activities. Based, in part on these experiments, Flight Control was registered with the U.S. Environmental Protection Agency (EPA) as a bird repellant by Environmental Biocontrol International, Wilmington, DE, in January 1999.

Title: Management Strategies To Control Blackbird Damage in the United States

Goal: Reduce the magnitude of health, safety, and nuisance problems caused by blackbirds and improve agricultural production by reducing blackbird depredation losses in citrus- and fruit-producing enterprises and in sprouting and ripening corn, sunflower, rice, and other grains.

Determination of the Fate of Bird Carcasses During Early Spring—In spring 1997 and 1998, NWRC and North Dakota State University (NDSU) scientists placed bird carcasses in cropland, grassland, roadsides, and wooded habitats in South Dakota to determine if blackbirds that had consumed DRC–1339-treated baits would be likely to be scavenged. Scavenging rates were faster in wooded areas than in the other three habitats. Carcasses monitored by cameras showed that striped skunks were the most common mammalian scavenger and red-tailed hawks, the most common avian scavenger. Observations revealed 13 species of raptors using the study area. The most frequently encountered raptors were American kestrels (33 percent) and red-tailed hawks (31 percent). Peak numbers of raptors occurred between March 29 and April 4, which is just before DRC–1339 baiting to control blackbird damage to sunflowers begins in most years. Few cats, crows, owls, or other scavengers or predators that are sensitive to DRC–1339 were observed feeding on carcasses. Thus, the overall risk of secondary poisoning following the use of DCR–1339 appears to be low.

Effects of Managing Wetland Vegetation on Ring-Necked Pheasant Populations—Ring-necked pheasants frequently use cattail wetlands as winter habitat in North Dakota. Managing dense cattail stands with glyphosate herbicide reduces blackbird roosting habitat but may also affect pheasant populations. To evaluate this risk, NWRC and NDSU scientists monitored habitat use and survival of 100 radiotagged female pheasants. Pheasants preferred wetlands with semipermanent water and dense stands of cattails during normal winters but used grass-covered uplands during mild and dry winters. Pheasants tended to use the wetland edges for cover during both normal and mild winters. Numbers of breeding pheasants were positively correlated with the amount of available grassland habitat. The investigators concluded that managers can improve the safety and effectiveness of current cattail management practices by focusing herbicide sprays in the center of wetlands, where blackbirds usually concentrate, and avoiding the spraying of wetland edges, where pheasants tend to reside.

Control of Blackbird Damage in Ripening Rice—Red-winged blackbirds and related species cause millions of dollars' worth of damage to ripening rice in the Southeastern United States during the late summer and early fall. The most common management strategy (harassing birds with various scare devices, noisemakers, and shotguns) usually is ineffective for reducing damage. Chemical feeding deterrents constitute an alternate, potentially more effective management option, but as yet no compound is registered for use in ripening rice. NWRC scientists evaluated Flight Control as a bird repellant for ripening rice. This product contains 50 percent anthraquinone as the active ingredient. Blackbird use of two 10-acre study plots that had been sprayed with Flight Control in southwestern Louisiana declined sharply within 24 hours of application, and no birds used the plots 2 days after treatment. A corresponding decline in the use of nearby unsprayed control plots also occurred, suggesting that birds left the area. These trials indicate that Flight Control can protect ripening rice from blackbird depredations for at least 7 days. However, in many fields protection needs to be extended to at least 2–3 weeks. Therefore, NWRC scientists plan to conduct additional tests to evaluate the cost effectiveness of different rates and application patterns and determine resulting residues on rice panicles.

Overspraying of Flight Control To Control Blackbird Damage to Newly Planted Rice—Cage, pen, and field studies have demonstrated the effectiveness of Flight Control for deterring depredations by blackbirds on rice seeds. However, treating rice seeds depends upon the availability and capacity of seed treatment machinery. NWRC evaluated an alternative method of applying Flight Control to newly planted rice: overspraying it on fields after untreated seed had been planted and exposed to bird pressure.

In small pen (10 x 30 x 7 ft) tests, three levels of treatment equivalent to field application of Flight Control at rates of 1, 2.5, and 4 gal/acre were evaluated. Blackbirds exposed to the lowest treatment rate consumed almost 75 percent of the rice seed, but birds exposed to the 2.5- and 4-gallon-per-acre rates removed less than 20 percent of the available treated seed. Subsequent tests conducted in a one-half acre flight pen produced similar results. During 3 separate 10-day trials, test flocks consisting of 10 male red-winged blackbirds removed 58 percent of the rice seed from unsprayed control plots but just 6 percent of the rice from plots oversprayed with Flight Control at the rate of 2.5 gal/acre.

The positive results from the tests with captive birds led to a field evaluation of the overspray approach in Louisiana. NWRC scientists conducted the study during March 1999 at six study sites that were expected to have serious blackbird damage problems. Field use of this technique was not successful, however. There was no blackbird repellancy at any of the treated sites. The behavior of blackbirds in the treated plots indicated that there was insufficient anthraquinone on sprouted seed to produce a conditioned avoidance response. Subsequent analysis of rice from the test plots confirmed that anthraquinone residues on the seed were too low to deter depredating blackbirds. For overspraying to be practical and effective, the chemical needs to be delivered more efficiently to seeds planted in muddy fields.

Louisiana Rice Farmers Association Supports DRC–1339 Confined Rotational Crop Study for Blackbird Staging Area Label—The WS program has been using DRC–1339-treated brown rice baits on blackbird staging areas since 1989 to manage blackbird populations causing damage to newly planted rice. On March 15, 1995, EPA granted a Federal Section 3 registration for terrestrial nonfood uses of DRC–1339 concentrate in staging areas. However, this registration imposed a 1-year fallow period following any application of DRC–1339 on ground used for growing crops. This restriction has had a major impact on the effectiveness of blackbird management programs in States such as Louisiana and Texas by severely reducing areas that can be baited. EPA required that a C14 Confined Rotational Crop Study be completed before the agency would consider amending the label to allow baiting on crop lands. Confined rotational crop studies require that residue levels from the parent compound, in this case CPTH, be determined in three types of crops (a grain, root, and leafy vegetable) over preset plantback intervals. Louisiana rice growers selected rice, carrots, and soybeans as the representative crops. Because DRC–1339 is used in other States such as the Dakotas, wheat was also included as a representative crop.

The distribution of DRC–1339 residues from mature harvest samples was 0.003, 0.009, and 0.007 parts per million (p/m) at 15-, 30-, and 60-day plantback intervals for wheat; 0.013 and 0.002 p/m at 30- and 60-day plantback intervals for soybeans; and 0.006 p/m at 30- and 60-day plantback intervals for carrots, respectively. Residues for rice were similar to those for wheat. Most residue levels were well below EPA's established level of 0.01 ppm and were "bound residues" that could not be extracted from the mature seed through an acid wash. The data from this study will be submitted to EPA to support any DRC–1339 staging label changes.

Title: Development of Nonlethal Chemical Repellants for Birds

Goal: Develop methodologies that contribute toward the discovery and practical development of nonlethal, environmentally benign chemical repellants for use in resolving conflicts between wildlife and agriculture and industry.

Discovery of Sweet Antagonists for Birds—NWRC scientists are studying the complexity of physiological and behavioral mechanisms that allow animals to process and perceive sensory cues associated with foods. Such studies are important to agriculture because, in an ecological context, the dynamic changes that occur in fruits influence the timing of frugivory, and by implication, the optimal timing of seed dispersal by vertebrates. NWRC scientists characterized the preference and aversions of European starlings for mixtures of natural plant products from two different functional classes of trigeminal (pain) irritants, methyl anthranilate (a pungent compound to birds), tannic acid (an astringent), and fructose (a sweet taste highly preferred by birds).

Starlings preferred simple solutions of fructose as a function of increasing concentration and avoided simple solutions of methyl anthranilate or tannic acid as a function of increasing concentration. Starlings avoided mixtures of methyl anthranilate and tannic acid as if they were attending to the most unpalatable concentration of a single component, which is contrary to expectations based on existing models of sensory systems. When in a two-component mixture, fructose overshadowed the unpalatable properties of methyl anthranilate as well as the unpalatable properties of tannic acid. However, when fructose was tested in the presence of minute quantities of both methyl anthranilate and tannic acid for low concentrations of the repellants that would otherwise be inoffensive to the birds, the preference for fructose was completely eliminated. These results are important to understanding how plants may be able to manipulate the behavior of seed dispersers and prevent untimely fruiting. The observations also suggest that it may be possible to develop natural product based formulations to mask the sweet taste of ripened fruit.

Development of Cell Culture as a Wildlife Management Tool To Screen Primary Repellants—The identification of new chemical repellants for wildlife damage management is impeded by the need to perform cumbersome and expensive behavioral tests on live animals. Monell Chemical Senses Center and NWRC scientists have developed cell-culture methods to increase the speed and efficiency of this screening process and reduce the number of animals needed to identify and screen potential repellants. These methods exploit the dependence of effective primary repellants on the stimulation of pain receptors. Cell cultures of trigeminal neurons from rats, chickens, coyotes, white-tailed deer, and Canada geese were successfully developed. The technique relies on digital fluorescence microscopy to measure changes in intracellular calcium (an index of cellular activation) in response to applications of effective repellants and pain-transmitting neurotransmitters. Repellancy results from cell-culture tests were consistent with behavioral data for well-described mammalian and avian irritants, such as capsaicin and methyl anthranilate for live animals. This assay will allow scientists to develop predictive models that may permit the synthesis of novel repellants and will serve as a basis for an economical screening for candidate repellants derived from natural products.

Converting Primary Repellants Into Secondary Repellants—Primary repellants are typically painful or irritating agents that produce a reflexive withdrawal of the target animal from the treated substance. The advantage of primary repellants is that they often are derived from natural products that have few adverse environmental consequences. However, their effectiveness is frequently limited because animals take steps to reduce their exposure to these irritating substances. Hence primary repellants do not promote long-term avoidance learning. Secondary repellants are generally toxicants that, in sublethal doses, cause severe illness. Target animals strongly learn to avoid exposure to secondary repellants, which they associate with illness. Historically, the best commercial repellants have been secondary ones. Unfortunately, toxicological and environmental concerns frequently arise with the use of secondary repellants, and thus their commercial availability has virtually vanished.

NWRC scientists in Fort Collins demonstrated that application via intubation of a primary repellant to the gastrointestinal tract of birds can produce enteric illness to which the birds form strong learned aversions on the basis of visual cues. This result demonstrates that primary repellants can yield learned aversions as strong as those elicited by secondary repellants with less impact on the environment and have higher margins of safety in their toxic effects. Future studies will focus on encapsulation methods of these primary repellants. This process will ensure that sufficient quantities of the material are freely eaten by birds so that the desired level of enteric illness will be achieved, and a strong conditioned aversions will be established.

MAMMAL RESEARCH PROGRAM

Title: Ecology of Coyote Depredation

Goal: Determine interrelationships between depredation on livestock and the abundance and behavior of predators and natural prey.

A Technical Review of Methods and Strategies for Managing Coyote Predation on Livestock—Coyote depredation on sheep is the single greatest cause of economic loss to producers in many Western States. For this reason, various management methods have been developed to manage depredation. None of these methods is universally effective in all situations. Because management of livestock depredation by coyotes is often a controversial and emotionally charged issue, NWRC scientists reviewed the extensive technical literature in this area in an attempt to define the benefits and impacts of coyote management activities. A summary of this important research review follows.

Depredation management strategies may be either preventive or corrective. Preventive techniques are implemented before losses occur. These techniques do not usually involve removing coyotes, and many tactics can be implemented by livestock producers. Corrective methods are implemented after losses occur and, typically, after preventive methods have failed. Corrective strategies involve efforts to remove offending animals from the vicinity of livestock. This work requires a high degree of skill, and, usually, the participation of wildlife professionals.

Among preventive methods, the use of fencing on small pastures, certain husbandry practices such as shed lambing and the presence of herders, and the use of guard animals such as dogs or llamas can provide some relief. However, the use of some preventive methods can diminish the effectiveness of corrective methods should depredations occur. For example, calling and shooting, traps, and snares cannot be used around guard dogs because dogs are attracted by calling, and they are likely to be trapped or snared. Frightening devices are marginally useful unless employed as part of a coordinated management program. Although predation may stop temporarily, coyotes readily habituate to frightening devices, and depredations are likely to resume after a few days or weeks. Aversive conditioning approaches (i.e., conditioned taste aversions) have not been useful: although training affects consumption, it does not affect the chasing, harassing, or killing behaviors coyotes direct toward livestock. At present, there are no effective chemical repellants that deter coyote predation—only substances that deter consumption of inanimate objects.

Reproductive intervention to modify the predatory behavior of coyotes (not as a large-scale population control strategy) holds considerable promise as a technique and is a subject of intensive investigation. Although orally deliverable substances and delivery systems remain to be developed, reproductive inhibitors are likely to work well in areas where sheep are a seasonal food source for coyotes provisioning offspring. However, where sheep are perpetually available (e.g., coastal California, Texas), predation is not tied to pup production, and reproductive intervention is less likely to have desirable effects.

Corrective methods are implemented when nonlethal ones are impractical or ineffective. Typically, large livestock operations on open ranges resort to lethal control when guard animals and shepherds fail to curtail depredation. Local population reduction can provide temporary relief in such situations, but only until the local coyote population compensates for the removals and fills territories where territory holders have been removed. Population reduction as a management option usually requires annual effort because of reproduction and the dispersal of juveniles and transients into emptied territories. One lethal technique that selectively targets offending coyotes is use of the Livestock Protection Collar. This device is closely regulated by the EPA and is not available in all States. Traditional methods of capture (traps, snares) can remove offending animals, but the effective use of these methods requires a high degree of expertise and considerable time. Regulations regarding lethal control and removal of coyotes must be examined before implementing such programs; permits may be required for some activities. Four States (Arizona, California, Colorado, Massachusetts) currently restrict the use of leghold traps and snares. Other States (e.g., Arizona, Utah) have specific limits on aerial hunting practices.

Effective management of livestock predation by coyotes clearly requires partnership approaches between producers and wildlife professionals using a variety of tactics selected in relation to the particular problem and appropriate to the local situation.

Title: Sensory and Behavioral Methods for Managing Coyote Predation on Livestock

Goal: Identify chemical repellants and deterrent methods and create attractive baits for target-specific delivery of pharmaceutical substances to reduce livestock depredation.

Field Trials of Llamas as Livestock Guards—Many sheep producers use guard dogs to protect their flocks from coyotes and other predators. Dogs are often effective for this purpose, but they are expensive to buy and maintain, have a short lifespan, and sometimes attack sheep. Likewise, if coyote depredations continue, the presence of guard dogs can interfere with the use of other management methods (calling and shooting, traps, and snares). NWRC recently completed investigations examining whether llamas could serve as an effective guarding animal alternative to guard dogs. Llamas are inexpensive to purchase and maintain, have a longer lifespan, do not affect the implementation of other strategies, and require no training or socialization period to attend sheep.

To assess the effectiveness of llamas as livestock guardians, NWRC investigators compared loss rates between flocks with and without these animals in a 2-year study. During the first year, flocks with llamas had 50 percent fewer losses than flocks without llamas. During the second year, losses remained constant for flocks with llamas, but depredation rates among control flocks declined. These results suggest that depredation may have to reach some threshold level before guard llamas can effectively affect loss. Although data are scarce, the same may be true of other guardian animals. Initially, producers who participated in the study had no opinion about the effectiveness of llamas as guard animals. However, after participating for 2 years, nearly all producers considered llamas to be "effective" or "very effective" in reducing depredation. Most participating producers purchased the test llamas to continue use with their sheep.

Title: Development and Evaluation of New Techniques for Resolving Predator Depredation Problems

Goal: Develop new or improved control technology systems for operational use in predator management.

Radio-Activated Frightening Device for Livestock Predators—Adverse interactions between humans and wildlife require situation specific management solutions. In small areas such as calving pastures, frightening devices incorporating light and sound stimuli can reduce canid depredations, but animal habituation to randomly activating stimuli limits the effectiveness of the technique. Limiting frightening stimuli so that they occur only during the presence of an intruding predator (e.g., a wolf) is likely to increase time to habituation and more effectively protect a particular area.

With assistance from FWS and a grant from the Defenders of Wildlife, NWRC scientists have developed a radio-activated Electronic

Guard that activates when radio-collared predators approach the device. The concept for this approach was based largely on ideas from local ranchers. In a field test, the Electronic Guard performed well in the harsh weather conditions of a Montana spring. It operated for almost 2 months and activated as designed during repeated tests of the system. Current plans are to make specific engineering improvements in the device and to begin controlled testing of an improved prototype.

Improving the Ability To Monitor Coyotes and Other Species—Animal tracks can be a clue to the presence of individuals and relative abundance of species. NWRC scientists have tested a passive tracking-plot index for monitoring coyote activity in southern Texas before and after trapping programs. Observations were made on a series of tracking plots placed on lightly used dirt roads. The number of sets of tracks (individual intrusions) was recorded for each species on each plot on 4 consecutive days. No scents, baits, or other attractants were used. The mean number of intrusions over the plots was calculated for each day for any species that used the plots. The population index was obtained from the average of the daily intrusions over the 4-day period. Statistical properties inherent to this data structure permitted the calculation of standard errors, confidence intervals, and statistical tests without subjectively subdividing the data. Scientists were able to monitor changes in coyote populations before and after each of three trapping programs. Simultaneously, they were able to monitor populations of seven other species (bobcats, white-tailed deer, feral pigs, javelina, raccoons, rabbits, and unidentified rodents). The results demonstrated that this index was far more sensitive to change than traditional tracking surveys in which only the presence or absence of tracks is recorded at each plot. Placement of plots farther offroad resulted in reduced detectability of animals and also a lower sensitivity to change in population size.

Title: Management of Livestock Depredation: Developing More Selective Control Strategies

Goal: Develop effective and environmentally responsible strategies for reducing livestock depredation through selective targeting of predators.

Identifying Territorial, Dominant Coyotes—Previous NWRC research, based at the University of California's Hopland Research and Extension Center, showed that territorial, dominant coyotes are the principal killers of sheep, whereas subordinate, young, and transient animals are rarely involved. A second phase of research is currently under way to learn more about the behavior unique to territorial coyotes and how to exploit it for improved predation management. This research is being conducted at the 38,000-acre Dye Creek Preserve in northern California. Coyotes are being captured and instrumented with radio collars to determine the animals' space-use patterns and social status. In one study, coyote responses to broadcast howling are being investigated. "Calling and shooting" is a method of coyote removal that has potential for selectively targeting territorial, dominant animals. Field testing is under way to determine if territorial, dominant coyotes are the most likely to approach a source of broadcast howling that might represent an intruder. If so, the relationship between the type of vocalization, season, or time of day will be determined. Trials conducted during the winter of 1999 showed that coyotes responded to broadcast howling both individually and in groups by one or more of the following behaviors: howling, circling downwind, approaching, or retreating.

For subsequent trials, a digital sound system activated by a cell phone is being developed. It will broadcast a choice of vocalizations or prey distress calls by dialing a pager wired to the player. This will help ensure that coyotes are detecting and responding to the researchers rather than to the source of the call. In addition, computer analysis of the sonographs of coyote vocalizations is being done to determine whether howls, or other vocalizations, can be characterized by sex, age, or social status. If they can, different types of vocalizations can be tested to determine those that might be most effective in eliciting the approach responses of the territorial, dominant coyotes.

In a second study, wariness in territorial, dominant coyotes is being investigated to determine if it influences investigation of an object or food associated with a control efforts. This was suggested by findings at Hopland and in other studies that indicated differential coyote vulnerability to capture methods depending on age, social status, and previous exposure to control. An understanding of wariness and neophobia toward control devices might allow for more effective choice and presentation of methods. In addition, factors affecting the rate at which territorial, dominant coyotes encounter objects within their territories are being investigated such as placement on versus off roads, core territory versus periphery, and areas with heavy versus light human traffic.

Title: Analysis of Taste and Olfaction in Selected Wildlife Species

Goal: Apply the methodology and findings from basic multidisciplinary chemosensory research to the development of new methods for controlling wildlife damage.

New Synthetic Coyote Attractants—During 1998, analyses of 33 chemical and conventional attractants by NWRC scientists led to the development and formulation of 7 new synthetic coyote attractants. Preliminary results from bioassays conducted with captive coyotes indicated that at least three of these new attractants elicited increased desirable behavioral responses as compared with fatty acid scent, which is currently one of the most effective attractants. Bite–pull responses are more common with the new attractants, and these behaviors persist for longer periods of time as compared to the synthetic fatty acid scent. Results are encouraging in that one or more of the synthetic attractants may prove to be exceptionally effective.

Title: Control of Rodent Damage to Hawaiian Agricultural Crops

Goal: Develop safer and more effective methods for reducing rat damage to Hawaiian agricultural crops.

New Rodenticide Use Patterns for Roof Rat Control in Hawaiian Macadamia Orchards Registered—Rats damage an estimated 5 to 10 percent of the nut crop in Hawaiian macadamia orchards. Relevant aspects of roof-rat biology are being studied at the NWRC Hilo, HI, field station with the ultimate goal of developing an ecologically sound and cost-effective integrated pest management plan. This research recently aided the Hawaii macadamia industry in obtaining a State registration for use of the anticoagulant rodenticide diphacinone in bait boxes placed in macadamia trees. Research findings suggest that roof rats are the primary rodent pest species of concern for macadamia producers. Roof rats in Hawaiian macadamia orchards forage primarily in trees, and broadcast baiting of rodenticides on the ground of macadamia orchards without interior vegetation is ineffective for roof-rat control. This new registration provides producers with an effective means to control rodents in macadamia orchards and reduces the risk of direct nontarget hazards by bait-box placement in trees.

Title: Reducing Wildlife Damage to Forest Resources

Goal: Provide feasible and effective methods for reducing wildlife damage to forest resources.

Assessing and Improving Fumigant Dispersal in Pocket Gopher Burrows— NWRC's Olympia, WA, field station is collaborating with the USDA Forest Service's Missoula Technology and Development Center to develop better ways to reduce pocket gopher damage to tree seedlings. Efforts to establish tree seedlings on sites infested with pocket gophers can be futile unless population reduction measures are implemented. Strychnine baiting and trapping have been standard tools to limit pocket gopher populations, but concerns with potential hazards of strychnine baiting may jeopardize its use in the future. Alternative means to reduce pocket gopher populations are needed. Fumigants offer one possible alternative for reducing pocket gopher occupancy of reforested areas. Fumigant efficacy, however, is generally low when used to reduce pocket gopher populations.

Two experiments were conducted to determine the movement of fumigants through burrow systems and assess the potential benefits of using a portable blower system to obtain better burrow penetration. The first experiment investigated the movement of the carbon monoxide produced by burning smoke cartridges through an artificial burrow system. Carbon monoxide was introduced to the system by burning either one cartridge or two cartridges concurrently or consecutively. Burning the cartridges without a blower was not effective in distributing the fumigant. A blower was used to distribute the carbon monoxide at different speeds and durations. The most effective dispersal occurred when the blower was used at a low speed while the cartridge was burning. Using the blower at higher speeds or for longer periods only introduced fresh air to the system and dissipated the fumigant. Burning two cartridges simultaneously was the most effective burn configuration.

The second experiment repeated the initial trial using an actual but vacant pocket-gopher burrow systems rather than an artificial system. Results from these trials were similar to those in the first experiment. Field trials are needed to determine whether enhancing fumigant dispersal could improve the effectiveness of fumigants on reforestation sites.

Developing Methods To Enhance Direct Tree Seeding for Reforestation Projects—Rodents can be a hindrance to seedling production at tree nurseries or in reforestation efforts through direct seeding. Mice either eat seeds or carry them to a food cache. NWRC is working with the Forest Service to assess whether repellants can be used to inhibit seed predation by mice. Potential repellants tested included capsicum, thiram, and a capsicum–thiram mixture. Deer mice and house mice were offered ponderosa pine seeds treated with one of these repellants along with control seeds to assess repellancy. All three repellants reduced house mouse consumption of treated seeds relative to untreated seeds. Responses of deer mice, however, varied among treatments. Deer mice ingested fewer seeds treated with the mixture than untreated seeds, but neither the capsicum nor thiram alone reduced seed predation relative to controls. These results indicate that the mixture of materials may be an effective means to enhance seedling establishment.

PRODUCT DEVELOPMENT RESEARCH PROGRAM

Title: Integrated Pest Management Strategies for Rodent Damage to Agriculture

Goal: Develop, test, and evaluate innovative and integrated methods and models to reduce rodent damage to agricultural crops and property.

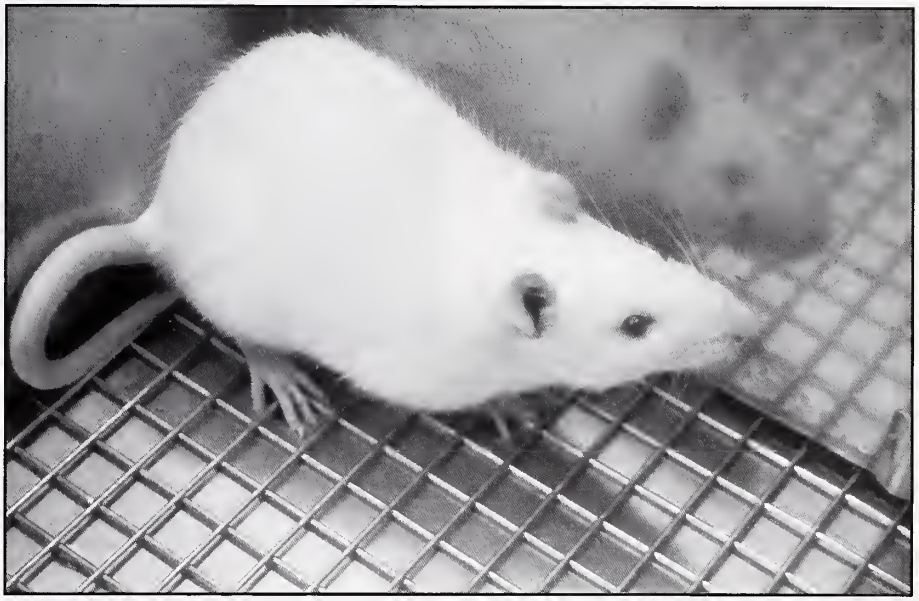
Reproductive Inhibition of Black-Tailed Prairie Dogs—Prairie dogs are considered undesirable when they compete with livestock for forage, excavate burrows, destroy landscaping, and transmit plague. Historically, conflicts with prairie dogs have been resolved by the use of burrow fumigants, poison grain baits, or shooting. Such methods have become increasingly unpopular with some sectors of the public. Contraceptives may be more promising for controlling prairie dog populations; however, the effects of this approach on behavior and social structure are unknown. Surgical sterilization provides a means for modeling these effects.

NWRC scientists and a CSU graduate student used surgical castration of male prairie dogs to simulate the effects of a contraceptive that would cause gonadal atrophy. The animals in 16 coteries (territorial social units) were marked and identified through trapping and observations. Before the breeding season, the males in eight treatment coteries were castrated, and the males in eight control coteries were sham-treated. No obvious differences were noted in the number of lactating females, emergent pups, invaders, and dispersers between treatment and control groups. These results suggest that a contraceptive that alters male hormonal levels may have minimal impact on prairie-dog social structure. Female-based contraceptives may be necessary to minimize reproduction.

Reducing Norway Rat Damage to Communication and Power Cables— Rodents cause considerable damage to power and communication cable systems both above and below ground. A method for applying chemical repellants to these materials is needed to reduce damage from rodent gnawing. In laboratory tests at NWRC, scientists used time-lapse video recordings to learn that Norway rat behaviors associated with gnawing damage often involve the animal's placing its paws on the cable and shredding and pulling apart pieces of wire and cable covering with its incisors. Understanding such behaviors can provide the key to ensuring better repellent chemical contact with the rat's nose, mouth, and eyes during gnawing. For example, significant repellent effects, as measured by reduction in the volume of cable material gnawed over 7-day exposure periods, were observed with 2-percent capsaicin oleoresin ("hot sauce") and denatonium benzoate (a very bitter compound) repellent formulations when they were contained within shrink tubing placed around the cable. Damage reduction over this time period was 75 to 80 percent with this application method. Previous tests with wild Norway rats have shown that these chemical repellants afford no protection to cable samples at the 2-percent concentration when only applied topically. Further studies will evaluate other cable coverings with the goal of developing repellent products that can be applied either directly in the manufacturing process or during the installation of cable systems.

Title: Evaluation of Rodent Control Chemicals

Goal: Develop safe, effective chemical methods to reduce rodent damage to agricultural crops and rangeland and to provide for public health and safety.



Efficacy of Cholecalciferol (Vitamin D3) Oat Baits for Controlling Thirteen-Lined Ground Squirrels—Thirteen-lined ground squirrels can consume enormous amounts of corn seed after seeds have been planted by the no-till method. Replanting a damaged site is often costly to farmers and causes delays in production time. In addition, thirteen-lined ground squirrels have been known to damage greens and fairways at golf courses and the underground wiring of runway lights at airports.

NWRC scientists evaluated two concentrations (0.1 percent and 0.5 percent) of cholecalciferol (Vitamin D3) as a potential tool to control thirteen-lined ground squirrels. This small-scale study was conducted at the municipal airport in Cherokee, IA, where airport personnel have been experiencing problems with this species for some time. The two concentrations were formulated on steamed rolled oats and then placed at each burrow entrance on two separate treatment units. Visual counts before and after treatment were used to evaluate efficacy on each treatment unit. At the site receiving the 0.1-percent treatment, visual counts dropped from a daily average of 10 animals to none—a 100-percent reduction. At the site receiving the 0.5-percent treatment, visual counts dropped from a daily average of 38 animals to 5 after treatment—an 87-percent reduction. Results from this field test demonstrate cholecalciferol's effectiveness in controlling thirteen-lined ground squirrels in the field and reinforce previously collected laboratory data.

Laboratory Testing of Zinc Phosphide on Deer Mice—Deer mice are a carrier of hantavirus and can also cause damage to agricultural crops. Few tools are available to control deer mouse populations. Zinc phosphide was tested to collect efficacy data for EPA reregistration requirements and potentially to add deer mice to the APHIS wheat and oat zinc-phosphide bait labels. The treated wheat bait and the treated oat bait were tested in 3-day, two choice tests. The second-choice food, a mixture called rat and mouse challenge diet, was recommended by EPA. A deer mouse colony was established at the NWRC in Fort Collins. Sixty animals (30 of each sex) were selected for each test, and 20 animals were assigned to each concentration tested: control (0.00 percent), 1.82 percent wheat bait treatment, and 2.0 percent oat bait. Mice were fed the treated baits and the rat and mouse challenge diet for 3 days. Mice preferred oat-groat baits over wheat baits. Mortality in mice ranged from 40 to 80 percent for the 1.82 percent wheat bait test, and the overall mean mortality rate for this test was 60 percent. Mortality for mice treated with the 2.0-percent oat-groat bait ranged from 60 to 90 percent with an overall mean mortality rate of 80 percent. No control animals died. Only the oat bait produced the generally acceptable mortality rate set by EPA for laboratory studies (70 percent). The data will allow APHIS to maintain use of zinc phosphide for control of deer mice.

Chlorophacinone and Diphacinone: Anticoagulant Laboratory Tests—California, in cooperation with NWRC, is attempting to find safe alternative rodenticides to replace the canceled Compound 1080. The California Vertebrate Pest Control Research Advisory Committee funded laboratory studies at NWRC through a cooperative agreement with the California Department of Food and Agriculture (CDFA). The objective was to obtain efficacy data for control of commensal house mice that would fulfill requirements established by EPA for the reregistration of four of CDFA's pesticide labels: 0.01-percent chlorophacinone grain bait, 0.01-percent diphacinone grain bait, 0.005-percent chlorophacinone wax bait, and 0.005 percent diphacinone wax bait.

To evaluate these possible alternative rodenticides, mice were placed on 15-day, two-choice feeding and efficacy trials. The control groups of mice received two dishes each containing EPA's designated standard rat and mouse challenge diet. The treated groups received one dish of the challenge diet and a second dish of the treated grain baits (0.01 percent chlorophacinone or 0.01 percent diphacinone) or the treated wax bait blocks (0.005 percent chlorophacinone and 0.005 percent diphacinone).

Mortality for the 0.01-percent chlorophacinone and 0.01-percent diphacinone grain baits ranged from 90 to 100 percent. For the wax bait blocks, mortality varied from 60 to 80 percent for the 0.005-percent chlorophacinone wax bait treatment and from 40 to 90 percent for the 0.005-percent diphacinone wax bait treatment. When bait blocks were weathered before being presented to the mice, mortality increased. Anticoagulant grain baits or weathered bait blocks would both have acceptable performance according to the EPA Pesticide Assessment Guidelines.

Zinc Phosphide: Norway Rat Laboratory Tests—Using funds provided by the same California committee, NWRC scientists evaluated 1.0- and 2.0-percent zinc phosphide oat-groat grain baits to control Norway rats in the laboratory. The rats were individually housed, and 40 were placed on control and 80 on treated baits for a 3-day, two-choice feeding study. Control rats received duplicate dishes containing standard rat and mouse challenge diet. The treated rats each received a dish containing the 1.0-percent or 2.0 percent treated bait and a second dish containing the challenge diet. After 24 hours' exposure to the 1.0-percent bait, 85 percent of the treated rats died; after 48 hours' exposure, two (5 percent) additional rats died. The four animals that survived consumed very little zinc phosphide. After 24 hours' exposure to the 2.0-percent bait, all 40 treated rats died. No

control rats died in either study. Mortality rates for zinc phosphide at both rates exceeded the minimum efficacy standard of 70 percent established by EPA for rodenticides.

Acrolein: Townsend's Ground Squirrel Fumigation Efficacy Study—The Baker Petrolite Corporation entered into a cooperative agreement with NWRC to determine the efficacy of the fumigant acrolein to control Townsend's ground squirrels. Efficacy data were obtained by injecting 20 cc of acrolein into the underground burrow systems of ground squirrels in central Washington during March 1998. Four treatment areas and a control area were established in apple and peach orchards and on an irrigation canal ditch bank. Ground squirrels were monitored before and after treatment using visual counts and a closed-hole index. Treatment efficacy averaged 91 percent based on visual counts and averaged 83 percent based on the closed-hole index. These values exceeded the 70-percent minimum standard established by EPA for reduction of rodent populations with fumigants.

Title: Development of Control Methods for Brown Tree Snake Management

Goal: Develop techniques to help control brown tree snakes on Guam and prevent their dispersal from that island.

Between 1995 and 1998, NWRC conducted research to identify chemicals (toxicants, fumigants, attractants, and repellants) to control brown tree snakes (BTS's). Beginning in 1999, NWRC began the first year of a potential multiyear effort to field-test these chemicals for eventual operational use. NWRC chemical methods development for BTS control has been funded primarily by the DoD Legacy Program and has recently been supplemented by the U.S. Geological Survey to help accelerate development of chemical control techniques.

Toxicants—During 1999, WS obtained an Emergency Use Permit (EUP) from EPA for field-testing 80-mg tablets of acetaminophen on BTS's on Guam. Acetaminophen was determined to be an effective toxicant in two field trials on multiple plots of 1 to about 6 ha. Preliminary analysis suggested that snake populations were reduced about 50 percent and 80 percent, respectively, in the 1- and 6-ha plot trials. The use of acetaminophen in these trials was based on earlier Center research that (1) evaluated aspirin, ibuprofen, acetaminophen, and caffeine as oral toxicants and pyrethrin as a dermal toxicant; (2) developed analytical chemistry techniques for the toxicants being tested on Guam; (3) identified PVC pipes as simple, effective toxicant bait delivery stations; and (4) video-monitored 5,568 hours at bait-delivery stations that detected only two monitor lizards as nontarget visitors. Under this EUP, acetaminophen can now be used on a limited scale by USDA–WS for 3 years to control BTS's.

Analytical Chemistry Development—NWRC chemistry personnel assisted in the development of these oral BTS toxicants. Promising snake toxicants were incorporated into coated and uncoated tablets for evaluation on Guam. Analytical methods were developed and used to confirm the concentration of toxicants in the tablets. Uncoated tablets proved to be the most efficacious, and acetaminophen and caffeine proved to be the most effective toxicants. Analytical chemistry methodology also was developed to analyze uncoated acetaminophen tablets and to quantify acetaminophen concentrations in mouse baits to support storage-stability and field-stability studies. The results indicated that acetaminophen concentrations degraded by approximately 1 percent per week during frozen storage, suggesting that acetaminophen mouse baits can be prepared in advance and

stored frozen for a number of weeks prior to use. This analytical methodology is also being used to determine the stability of acetaminophen mouse baits during field baiting through simulation in environmental chambers. The resulting data should provide information regarding the viability of acetaminophen baits over a 2- to 4-day period under field conditions.

Attractants—Center biologists identified the components of dead mouse odor. Through the use of a video surveillance system at the traps, biologists also confirmed that snakes are equally attracted to a trap site by a dead mouse and by just the odor of a dead mouse. Various matrices (e.g., soy- or gelatin-based or both) were evaluated with limited success to deliver these odors to BTS's. Development and evaluation of a visual lure (mechanical mouse) coupled with mouse odor were also continued, but with limited success.

Repellants—The dose-related responses of BTS's to previously identified natural product repellants using a new prototype "fogging" device were found to have limited success in driving snakes from simulated cargo situations. However, the results permit configuring a vaporizing machine to generate appropriate output levels of a repellent gas.

Fumigants—Methyl bromide is available for use as a cargo fumigant against the BTS. Sulfuryl fluoride and magnesium phosphide have also been shown to be effective but are not yet registered with EPA as fumigants effective against BTS's. NWRC has nearly completed preparation of the necessary data packages, which will be provided to current registrants for submission to EPA with the purpose of amending the existing labels of these two products to include the BTS.

Evaluation of Operational Control Methods—NWRC, with funds provided by the USDA–WS operation in Washington, Hawaii, and Guam, conducted methods development research to continue to improve results of detector-dog teams, evaluate new trap designs, compare spotlight searches versus traps along fencelines, and develop a prototype mouse–water food block to be used as a backup or replacement system or both, for the currently used potato–water food block in operational control trapping. Also, NWRC provided assistance to the USAF at Tyndall AFB in its attempt to identify characteristic odors of BTS.

Exploratory Reproductive Inhibition of Brown Tree Snakes—During 1999, NWRC also received funds from the DoD Legacy Program to determine the feasibility of reproductive inhibition as a control approach for the BTS. This work is a cooperative effort with USGS and Oregon State University (OSU). Little actual data are yet available from this primarily planning effort. A specific research plan for 1999 was completed as well as a proposal for this effort for FY 2000 and beyond. A concept paper assessing the feasibility of reproductive inhibition in the BTS is nearly complete. A colony of African house snakes was established at NWRC. This colony will serve as a surrogate for the BTS to test possible reproductive inhibition materials. A breeding colony of BTS's was established at OSU. One potential reproductive inhibition approach (nicarbazin) in the BTS was evaluated using the breeding colony at OSU. Although BTS's were bred in captivity for what is believed to be the first time, the overall poor breeding results (two eggs hatched) precluded assessment of the efficacy of nicarbazin. With FY 2000 DoD Legacy funding, a cooperative research effort toward further development of a reproductive inhibition technique for the BTS is under way. The development of such a technique for use on Guam could play an important role in large-scale population control of the BTS and also reduce the likelihood of their dispersal to other areas.

PROGRAM SUPPORT

APHIS Registration and Reregistration Status

NWRC's Registration Unit is responsible for coordinating the development of data required by EPA and FDA to maintain the registration of current APHIS vertebrate control products or develop future product registrations. APHIS has seven active ingredients currently registered with EPA: an avicide (DRC–1339 or Starlicide™), two rodenticides (strychnine, zinc phosphide), a fumigant (the gas cartridge, which contains carbon and sodium nitrate), and two predacides (Compound 1080 for use in the Livestock Protection Collar and sodium cyanide for use in the M–44).

Reregistration Status of APHIS Products—The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), reauthorized by Congress in 1988, required the reregistration of all APHIS vertebrate pesticide active ingredients. Progress on reregistration is as follows:

Gas Cartridge, Livestock Protection Collar, M–44, DRC–1339 (Starlicide)—All reregistration requirements have been met for these products. Two sizes of gas cartridges are registered for rodent and predator burrow fumigation. The M–44 is registered for use with coyotes, Arctic and other species of fox, wild dogs, and skunks. The Livestock Protection Collar is registered for protection of sheep and goats from coyote predation. Data and label submission for Starlicide, the last of these products to undergo reregistration, are still under review by EPA. APHIS currently has five approved Starlicide labels for use against corvids, gulls, pigeons, blackbirds, grackles, cowbirds, and starlings.

Strychnine—A strychnine Reregistration Eligibility Decision (RED) was issued by EPA in July 1996, approving reregistration of the technical product and requiring data submissions for end-use products. All data submissions, with the exception of one storage-stability study, have been submitted and accepted by EPA. The storage-stability study has been completed and should be submitted to EPA by January 2000. APHIS currently has four strychnine labels. All are registered only for underground uses to control pocket gophers. NWRC serves as the coordinator of the Strychnine Consortium, which was assembled to generate funds to develop requirements for all technical products. As a result of APHIS' participation in the Strychnine Consortium, it has submitted 20 studies to EPA since 1989.

Zinc Phosphide—The final APHIS product to undergo the reregistration process is the rodenticide zinc phosphide. APHIS maintains three zinc phosphide registrations for use on a variety of rodent species. In August 1998, EPA issued a RED for zinc phosphide and requested the submission of more than 33 data packages for the technical and APHIS end-use zinc phosphide products. APHIS coordinates the Zinc Phosphide Consortium to generate funds for data development of technical and end-use zinc phosphide products. As the consortium coordinator, NWRC contracted out to other laboratories, provided data summaries, or wrote seven data submissions for technical zinc phosphide. In addition, NWRC conducted and wrote 25 data submissions for the APHIS end-use products. All data requested in the zinc phosphide RED were submitted to EPA before the December 31, 1999, deadline, ensuring the availability of zinc phosphide products for future use.

Rodenticide Product Registration Meetings—NWRC's Product Development Research program manager and registration manager met with EPA personnel in Washington, DC, in February and July 1999 at EPA-sponsored stakeholder meetings. Discussions focused on reformulation changes for commensal rodenticides required by EPA in the August 1998 zinc phosphide and anticoagulant RED. In those RED documents, EPA required the addition of dyes and bittering agents to rodenticides used in and around buildings to reduce potential exposure of children. On the basis of information provided by NWRC scientists and other registrants at these meetings showing that product efficacy would be decreased by addition of bittering agents, EPA elected to rescind the reformulation requirements for commensal-use rodenticides.

FDA Registration Activities—APHIS has four Investigational New Animal Drug (INAD) authorizations with FDA. Two of the INAD's are for the immunocontraceptive materials gonadatrophin-releasing hormone (GnRH) and porcine zona pellucida (PZP). The other two INAD authorizations are for the immobilizing agents propiopromazine HCl, which is used in conjunction with predator traps, and alpha-chloralose (AC), which is used primarily for removing problem birds in urban settings. No new INAD authorizations were requested

from FDA during FY 1999. However, NWRC's registration unit provided 12 semiannual reports and project summaries to FDA for the four existing authorizations. Studies on white-tailed deer vaccinated with GnRH or PZP have shown both injected vaccines to be effective in reducing fawning rates. Efforts are under way to develop oral vaccine delivery mechanisms to make the techniques more appropriate for field use. AC continues to be used for the removal of problem birds in parks and zoos. Propiopromazine HCl (the active ingredient in the Tranquilizer Trap Device) used in conjunction with soft-catch traps is effective in minimizing injury to trapped predators, and its use has been extended to Guam for capturing feral dogs.

NWRC has initiated discussion with FDA and a private organization regarding cooperative research and registration for the development of a chemical contraceptive material for egg-laying species. This compound also shows potential for use against a variety of species, including the Canada goose and other waterfowl, blackbirds, and even the BTS. Research will begin in FY 2000 to evaluate this agent's pharmacokinetic properties in wildlife species and its potential as a contraceptive under field conditions.

New Product Registrations—NWRC has submitted applications for new registrations to EPA for two new uses for old compounds, methiocarb and acetaminophen. A Section 3 or nationwide registration has been applied for to allow the use of methiocarb as a chemical aversive agent placed in "dummy" eggs to reduce corvid depredation on eggs in nests of threatened and endangered species. EPA had not yet responded to the registration request at the end of FY 1999.

Through the efforts of NWRC scientists, it was discovered that acetaminophen is toxic to the BTS. APHIS obtained an EUR from EPA to use acetaminophen as a toxicant to assist with continuing multiagency efforts to control the BTS on Guam and to prevent its spread to other Pacific islands. Discussions are under way to determine the feasibility of APHIS' obtaining a nationwide registration for acetaminophen.

Data and Regulatory Assistance Provided to Federal, State, and Nongovernment Organizations—WS program personnel or other Government and nongovernment cooperators often contact NWRC's registration unit for access to, or summaries of, data produced by NWRC or others to include in Environmental Assessments, Environmental Impact Statements, and in Section 7 consultations with FWS. NWRC is the prime supplier of these data to the WS program and its cooperators, often including summaries and necessary interpretations. More than 100 significant requests were handled in FY 1999 by NWRC; most were partially or completely customized for the requester.

Pesticide and Drug Registration Files—Three pesticide and drug registration data bases have been developed by registration unit personnel. The Pesticide Registration File data base provides information on the status of individual data requirements for all APHIS or Consortia vertebrate pesticides. A cross-referenced bibliographic data base has been developed that contains all known citations of published and unpublished information on 22 pesticides and drugs of interest to the WS program. Finally, NWRC personnel continue to develop a DRC (Denver Research Center) Number data base. This searchable data base contains DRC numbers, chemical names, and Chemical Abstracts Service registry numbers for 6,800 chemicals that were screened for toxicity and repellancy between 1960 and 1987 by NWRC for pesticidal properties. Three new publications containing tables of toxicity data and a compendium have been produced from this data base and have been submitted for publication as a series.

Participation With International Pesticide Risk Assessment Efforts—Since June 1997, registration unit personnel have actively participated on the EPA-sponsored Ecological Committee on FIFRA Risk Assessment Methods. This committee provided recommendations to EPA's Office of Pesticide Programs concerning statistical and probability-based pesticide risk assessment methodology. EPA has begun to adopt some of the committee's recommendations for conducting routine environmental risk assessments. Additionally, registration unit personnel traveled to the Netherlands to participate in a workshop sponsored by the European Society of Environmental Toxicology and Chemistry Europe and the Organization for Economic Cooperation and Development whose purpose was to define standard methodology for conducting assessments of the effects of pesticides on birds.

PROVIDING WILDLIFE SERVICES

Goal: Provide high-quality wildlife damage-management services for our customers that result in the protection of agriculture, wildlife and other natural resources, property, and human health and safety.

NATIONAL SUPPORT

Reducing Beaver Damage Problems in the Southeastern United States—NWRC biologists are working with WS specialists to develop beaver management methods that more closely relate to regional problems. NWRC organized a session on this topic between September 20 and 24, 1998, that was hosted by the Mississippi WS office and attended by WS specialists from across the Southeastern United States. During this session, objectives for a comprehensive beaver damage research effort were identified and discussed in terms of methods development needs. Topics included attractants, search dogs, electronic frightening and detection devices, habitat modification, mechanical barriers, "natural" or "homemade" remedies, nontarget concerns, repellants, toxicants, trap development, information, and extension needs, and basic biological questions—in particular those regarding population dynamics and behavior. An NWRC wildlife biologist has been stationed at the WS Mississippi State office to help coordinate and conduct collaborative beaver studies. Initial efforts will identify factors favorable for the successful operation of waterflow devices and examine the feasibility of frightening devices to reduce beaver activity. NWRC is also planning studies with biologists at Mississippi State University to assess beaver population numbers and characterize beaver population dynamics and reproductive behaviors in the South and is participating with WS specialists across several States to assess the efficacy of textural repellants to reduce beaver gnawing and the efficacy of tension-adjustable trap triggers to reduce nontarget captures.

Rodenticide Product Registration Meeting—NWRC's Product Development Research program manager met with EPA personnel in Washington, DC, during February to discuss ongoing research with DRC–1339 and the addition of dyes and bittering agents to anticoagulant and zinc phosphide baits. EPA is asking registrants to reformulate rodenticide products that are used in and around buildings to reduce potential exposure to children. At the meeting, registrants provided information to EPA on use sites that should be included in any reformulation requirements and also discussed problems with the RED's for zinc phosphide and the anticoagulants. The final data requested in the RED will be provided to EPA by December 31, 1999. This final data submission ensures zinc phosphide will be available for future use.

WS Rabies Management Team Meeting—NWRC hosted the annual meeting of the WS Rabies Management Team in February 1999. The meeting was attended by

17 persons representing WS operations, State health departments, Cornell University, Centers for Disease Control and Prevention (CDC), APHIS' Policy and Program Development, the Southeastern Cooperative Wildlife Disease Study, and NWRC research biologists. The group discussed the results, difficulties, and research needs of the 1998 large-scale aerial oral rabies vaccine programs conducted in Vermont, New York, Ohio, and Texas. The number of rabies cases has dropped substantially in most aerially baited zones. The team also planned the year's activities, discussed preparation of an environmental assessment should the existing vaccine barrier be breached, and discussed the need for an economic assessment of the traditional rabies management versus the oral rabies vaccine program. The success of the team's efforts should reduce the risk of human exposure to rabid animals and stop the spread of these outbreaks.

Kirtland's Warbler Recovery Program— Biologists at NWRC's Sandusky, OH, field station captured 400 brown-headed cowbirds in April 1999 to be used in the cooperative recovery effort for the endangered Kirtland's warbler in Michigan. The cowbirds are used as decoys to trap other cowbirds in areas of jack pine forest where warblers nest, thereby reducing the incidence of nest parasitism during May and June. About 110,000 cowbirds have been removed from the warbler nesting area since the trapping program began in 1972. Since 1972, cowbird parasitism has been reduced from over 50 percent to less than 5 percent of nests, and the nesting population of warblers has increased from about 180 to over 800 pairs. NWRC has provided FWS with cowbirds for this endangered species project annually since 1980. Other agencies cooperating in this project include the Michigan Audubon Society, Michigan Department of Natural Resources, and the Forest Service.

Mule Deer Fawn Predation Study— Three NWRC biologists assisted the Idaho Fish and Game Department in a 5-year study of the impact of predation on survival rates of mule deer fawns. Twenty-eight 1 mile transects, covering eight game management units, were examined for coyote scats for coyote population and food habits assessment. Four of the areas have had coyotes removed by WS; the other four have experienced no coyote removals. This information will aid the Idaho Fish and Game Department in determining what effect coyote removal has on fawn mortality. One of the biologists helped Idaho Fish and Game Department personnel capture and radio-collar mule deer fawns. A total of 18 fawns were radio collared during a 1-week effort in June. The goal of the study is to collar 60 fawns to determine specific causes of any subsequent mortality.

Elk Depredation in the Black Hills of South Dakota—NWRC scientists visited South Dakota in July to view elk depredation problems at the request of the South Dakota Department of Game, Fish, and Parks. The elk population appears to be increasing with small "satellite" groups of animals colonizing new areas. It also appears that forest management practices in the Black Hills are contributing to increased carrying capacity for elk in the region. Although increased hunter harvest of the elk population has been attempted to reduce damage, mixed land ownership makes this difficult. Electric fences are being built to provide relief around some crop fields and haystacks, and farmers are being compensated for crop loss in some cases. Potential solutions and research approaches were discussed.

Rodent Control Operations at the Kansas City International Airport—In July and August, NWRC scientists surveyed small-mammal populations before and after rodent control operations at the Kansas City International Airport in Missouri. The WS Missouri State office has a contract with the airport to control rodent populations in an effort to reduce hawk and owl use of the airport, thus lessening the bird–aircraft strike hazard. EPA requires efficacy data to maintain

the registrations on rodenticides currently available for these kinds of activities. Although equal numbers of small mammals were captured before rodenticide baiting on two adjacent areas, after baiting about 90 percent fewer were captured on the baited area. Airport personnel have reported many fewer hawk and owl sightings since the initiation of the rodent control program.

Alpha-chloralose—AC has been used successfully by WS personnel to capture Canada geese throughout the United States since FDA approved its use in 1993. However, the standard bait formulation of AC and corn oil injected into bread is sometimes cumbersome and not always conducive to field operations. A possible solution to this problem is the development of AC tablets that can be placed into bread in the field and then fed to waterfowl. In August 1999, biologists from NWRC's Sandusky, OH, field station and the Kentucky WS office conducted a test with captive Canada geese to compare the effectiveness of AC in a tablet form prepared by an NWRC formulation chemist and the standard formulation. There was no difference in capture time between birds receiving tablets and the standard formulation. These results are promising for the development of a new AC formulation for use in field operations. Further testing with other waterfowl, as well as determining the stability of the AC tablets, are planned.

APHIS Technical Mission to Turkey—Between August 30 and September 3, an NWRC scientist participated in an APHIS Technical Mission that met with animal and plant health officials from the Turkish Ministry of Agriculture to discuss and identify possible areas of assistance as a result of the devastating earthquake that struck northwest Turkey on August 17, 1999. The other two team members were from APHIS' International Services units based in Austria and Belgium.

After several days spent visiting damaged sites and interacting with ministry officials, the team identified many agricultural issues that will need to be addressed and made recommendations on possible APHIS future assistance. The identified issues related to (1) the basic infrastructure of the regional offices for the Turkish Agricultural Ministry's having been severely affected and needing to be supported; (2) the ministry and farmers' needing assistance to address animal disease concerns; (3) livestock, poultry, and animal feed needing to be replaced on many farms; (4) rat problems being a public health concern, primarily in areas around tent camps; and (5) technical assistance being needed to control insect pest problems in fruit and olive orchards. NWRC prepared a proposal to address immediate rat problems around tent cities and longer term rodent damage issues related to agricultural production.

North Dakota Sunflower Field Surveys—Blackbirds annually damage millions of dollars' worth of sunflower in the northern Great Plains. In September, biologists from NWRC in Fort Collins, the NWRC Bismarck, ND, field station, the WS North and South Dakota operational program, and the WS National Environmental Protection Act staff participated in a tour of damaged sunflower fields sponsored by the North Dakota Commissioner of Agriculture to highlight this important bird pest problem. Information was provided on research currently being conducted to evaluate the effectiveness and safety of baiting with DRC–1339 to reduce blackbird populations during the fall and on operational plans currently under way to help manage blackbird damage. Other participants included biologists from FWS and members of the board of directors of the National Sunflower Association.

INTERNATIONAL COOPERATION

Mexico Bird–Aircraft Hazards—A biologist from NWRC's Sandusky, OH, field station completed a third trip to Mexico City in February to assist the Mexican Government and National University of Mexico in evaluating bird hazards at the existing Mexico City International Airport and at proposed sites for a new international airport. These consultations have been sponsored by the Mexican Ministry of Communication and Transport through an agreement with the FAA. Bird species hazardous to aviation, such as waterfowl, raptors, and vultures, are common in the Mexico City region, and the Mexican Government wants to ensure that their existing airport and the new airport are designed and managed to minimize attractiveness to birds. The biologists censused bird and rodent populations in appropriate areas throughout the Mexico City valley and made recommendations to minimize bird strike hazards at the proposed airport sites by developing and enhancing wetlands away from the proposed sites. Such advance planning is essential for developing environmentally sound and efficient bird hazard reduction programs for airports. Bird–aircraft collisions cost the aviation industry well over $1 billion/year worldwide. Bird strikes are of particular concern in Mexico City because of the high elevation (about 7,400 ft) of the existing and planned airport sites.

Dingo Assessments in Queensland, Australia—An NWRC scientist at Fort Collins collaborated with zoologists from the Department of Natural Resources in the Queensland State Government. Currently, data collected through a recently developed population-monitoring method are being used to examine management methods for reducing dingo predation of livestock. The monitoring method, which uses observations from passive tracking stations, was found to be very sensitive to the presence of wild canids as well as other species present in the area that may experience population responses to changes in dingo populations. Monitoring dingo populations is an important component in the management of livestock losses, and research results may have applications for coyotes in the United States.

UNITED STATES DEPARTMENT OF AGRICULTURE

VALUING AND INVESTING IN PEOPLE

Goal: Promote an organizational culture which values and invests in our people to support their professionalism, competency, and innovation as Federal leaders of wildlife damage management.

University and Graduate Student Involvement—During 1999, 11 NWRC scientists served on the graduate committees of 38 students at 9 universities. American universities included CSU, Mississippi State, North Dakota State, Utah State, Washington State, and the University of Florida. Foreign institutions included the University of Vienna, the University of Zagreb in Yugoslavia, and the Queensland University of Technology in Australia. Research conducted by these students supports the mission of the WS program.

Publication Recognition—Will Pitt, a biologist at NWRC's Logan, UT, field station, was recognized in August with a Top Paper Award (one of five such awards) for a paper published in the North American Journal of Fisheries Management during 1998. The authors of the article are W. C. Pitt, D. A. Beauchamp, and M. R. Conover, and its title is "Evaluation of Bioenergetics Models for Predicting Great Blue Heron Consumption of Rainbow Trout at Hatcheries." Results of the study showed that bioenergetic models can be used accurately to estimate fish consumption by depredating water birds. Estimates were most accurate when nonmigratory birds were involved and when reliable estimates of population size could be made.

The NWRC 1998 Publications Awards were given to the following journal articles:

Clark, L. 1998. Bird repellents: interaction of chemical agents in mixtures. Physiology and Behavior 64: 689–695.

Conner, M. M.; **Jaeger, M. M.;** Weller, T. J.; McCullough, D. R. 1999. Effect of coyote removal on sheep depredation in northern California. Journal of Wildlife Management 62(2): 690–699.

Kimball, B. A.; Nolte, D. L.; Engeman, R. M.; Johnston, J. J.; Stermitz, F. R. 1998. Chemically mediated foraging preference of black bears *(Ursus americanus).* Journal of Mammalogy 79: 448–456.

These three publications are excellent examples of the scope and quality of research being done by Center scientists to address a variety of wildlife damage issues.

Former NWRC Employees and Retirees—On February 19, 1999, NWRC hosted about 50 former Center employees and retirees at its newly open Wildlife Science Building in Fort Collins. For many participants, this was the first time they had returned to the Center. The theme of the gathering was "We're New" and highlighted the new facilities, name change, research process, ties with CSU, employees, and the role many of the former employees played in helping the Center succeed in making these changes happen.

Catfish Farmers of America Award—At their annual convention in New Orleans in February, the Catfish Farmers of America presented certificates of appreciation to representatives of the WS programs of Alabama, Arkansas, Louisiana, and Mississippi as well as to Mark Tobin, NWRC's previous Starkville, MS, field station leader, for their efforts in helping to reduce depredations by fish-eating birds at commercial aquaculture farms. Following these presentations to WS, Associate Deputy Administrator Bill Clay presented an award to Hugh Warren, executive vice president for the Catfish Farmers of America, recognizing that organization's active support of the WS program.

FAA Award—Richard Dolbeer, field station leader in Sandusky, OH, received recognition from the FAA at the 22d Annual Airport Conference in Hershey, PA, in March. The conference was attended by 500 people in the aviation industry. Dolbeer was recognized for his skillful leadership in developing plans to manage wildlife hazards at airports and efforts in the development and application of technological procedures that have directly benefited the aviation environment.

Sweet Rewards—On May 20, NWRC hosted Fort Collins Federal Employee Recognition Day. More than 100 hundred people from various Federal agencies attended this award event. Mr. Ray Martinez, Mayor of Fort Collins, made presentations to Federal employees in the area who have made

significant contributions. NWRC's supervisory veterinary medical officer, Albert Dale, was recognized for his efforts in diversity awareness.

USDA Secretary's Honor Awards—In June 1999, the WS program (operations and research) received the USDA Secretary of Agriculture Honors Award for its efforts in developing methods and implementing operational control strategies for BTS's on Guam between 1995 and 1998. This was a group award with recognition going to 21 WS employees; it is one of the most prestigious awards USDA can present. The Center's research in this area has been an impressive team effort and has involved a large number of Center employees, 12 of whom were award recipients. Past NWRC recipients of this award include the International Program Section in 1991, Phyllis Harris in 1994, and Richard Dolbeer in 1997.

EXCEL Program—APHIS is implementing a new EXCEL Program to provide learning and development opportunities for both new and experienced APHIS support employees in grades GS–2 through GS–9. The program focuses on building skills and uses an online skills assessment inventory to develop individually tailored learning contracts. Each participant is supported by his or her supervisor, the EXCEL manager, and a mentor. There are 19 participants in the current program which began April 5, 1999, and continues until April 2000. NWRC has three participants in this program. Joe Fuller, budget analyst, will pursue learning about the budget process. Stewart Penrod, purchasing agent, will expand his purchasing skills to help NWRC fulfill its goal of purchasing more from small businesses. He will also focus on improving his facilitation skills. Cynthia Wolpert, secretary, will increase her presentation and communication skills to help her in her duties as a member of the WS Equal Employment Opportunity Committee and Special Emphasis Program. In addition, all three employees will participate in train-the-trainer classes to assist them in their work assignments.

Leadership Excellence Program—WS initiated a second Leadership Excellence Program to prepare employees to use leadership skills in current positions and future careers. NWRC budget analyst Joe Fuller is one of 19 WS employees participating in this 18-month developmental program.

Photography Recognition—The WS Eastern Region sponsors an annual photo contest that is open to all WS employees located in the Eastern Region. Contest categories coincide with the WS strategic goals. Three awards were won by John Humphrey, NWRC biologist at the Gainesville, FL, field station. John won first and third places in the "Developing Methods" category with photos relating to an ongoing study of vulture movements and second place in the "Valuing and Investing in People" category for a photo of a shooter during a firearm safety training course. Copies of the winning slides have been added to the Eastern Regional Office and Legislative and Public Affairs slide collections to use in professional publications and presentations and to inform the public about the diversity of services and benefits available through the WS program.

Leadership Award—Richard Bruggers, Assistant Director at NWRC, was recognized by the APHIS Leadership Council for his involvement in and support of the USDA–APHIS Leadership for Today and Tomorrow Program between 1998 and 1999.

USDA and GSA Recognition—NWRC Director Richard Curnow received a USDA Certificate of Merit from Richard Rominger, USDA Deputy Secretary, for his creativity and leadership in establishing the NWRC. Curnow and William Dusenberry, program manager for facilites planning and development, also received similar recognition from the General Services Administration for their outstanding dedication during the construction of the NWRC Wildlife Science Building.

Avian Repellent Patent Awarded—NWRC's Sandusky field station leader and a former NWRC scientist have been awarded a U.S. patent for "Lime as an Avian Feeding Repellent." This patent is based on a series of experiments conducted between 1993 and 1996 that showed dolomitic hydrated lime to be an effective avian feeding repellant. An advantage of lime as a repellant is that EPA registration issues should be greatly simplified because lime is commonly applied to lawns and croplands for soil enhancement.

D-pulegone Patent Awarded—NWRC scientists from the Logan, UT, and Sandusky, OH, field stations, together with an analytical chemist at the Monell Chemical Senses Center in Philadelphia, PA, were awarded a U.S. patent for "Naturally Occurring Odiferous Animal Repellant." This patent is based on a series of experiments demonstrating that d-pulegone (the odor of pennyroyal, a wild mint) is an effective feeding deterrent to both birds and mammals. The aversiveness of d-pulegone is mediated by irritation and toxicity.

NWRC 1999 Sabbatic Award—Dave Goldade, NWRC chemist in Fort Collins, was awarded an NWRC sabbatical opportunity. Dave used this opportunity to pursue graduate courses and plan thesis research toward his Ph.D. at CSU. His research will focus on the mode of action and secondary impacts of CPT, a chemical used in alleviating bird damage.

NWRC Hosts Three Visiting Scientists—The new NWRC Wildlife Science Building in Fort Collins was designed to facilitate hosting students and visiting scientists while on sabbaticals or conducting collaborative research with NWRC staff.

NWRC hosted three such scientists in 1999. Dr. Scott Hygnstrom of the University of Nebraska spent portions of his sabbatical leave from his university at NWRC. He presented a seminar on his deer–agricultural damage research. Deer damage was especially acute during certain stages of plant development, and deer were very adept at using nearby refuges to avoid hunters. During his sabbatical, Dr. Hygnstrom planned collaborative research with NWRC scientists, learned about NWRC administrative structure and outreach, assessed opportunities for regional wildlife damage cooperative units, worked with NWRC library staff on an annotated bibliography on biological management of wildlife damage, and completed several manuscripts.

Mr. Ian Temby visited NWRC from May 25 through June 1, 1999. He is the wildlife damage control officer for the State of Victoria, Department of Natural Resources and Environment, Melbourne, Australia. His work involves the resolution of Australian wildlife–human conflict situations through a variety of methods, many of which are similar to those used by WS. Temby has been working extensively with damage to structures and crops by gulls and cockatoos and presented a seminar at NWRC on the problems, attempted solutions, and human dimensions of these conflicts in Australia. He is currently completing an M.S. degree program on his gull research at Deakin University. Temby included visits to several Center field stations during his travels in the United States. His trip was sponsored by a fellowship of the Winston Churchill Memorial Trust.

Dr. Abdel–Kawy Abdel–Hakim Farag (Dr. Hakim) spent a 6-month sabbatical at NWRC in Fort Collins. He is an assistant professor at Menoufiya University near Cairo, Egypt. His stay at NWRC was sponsored by the Egyptian Embassy Cultural and Educational Bureau. Hakim has worked extensively with rodent problems in Egypt, including brown and black rats, Nile rats, and other species. He completed his Ph.D. at Moscow University, studying microtine rodents. His interests are rodent repellants, pheromones, modeling populations and damage, developing effective baits using inexpensive materials such as waste grains, and gaining exposure to new technologies and literature. While in Fort Collins, Hakim worked on several ongoing rodent studies and initiated a rodent pheromone study.

UNITED STATES DEPARTMENT OF AGRICULTURE

INFORMATION AND COMMUNICATION

Goal: Collect and analyze internal and external information to monitor and enhance program effectiveness. Communicate internally and externally to accomplish our mission and to build an understanding of the Federal role in wildlife damage management.

INFORMATION SERVICES

NWRC's Information Services Unit—In FY 1999, the NWRC information services unit once again packed the Center's entire library collection into boxes and moved to its new quarters in the Wildlife Science Building. The additional space gained in this new building has allowed the Center to expand its services to the WS program, stakeholders, and the public. The library's new location, immediately off the main entrance to the building, has increased its visibility, and its new furnishings (including new periodical display shelving), public access computer terminal, and open room design make it very inviting and usable.

Library personnel continued to update the NWRC Website. The full text of each 1998 NWRC publications in PDF format was added to the site. New photos and project descriptions were included, and design changes were instituted. Each research program page is now directly linked from the homepage of the site. The Gainesville, FL, field station page was redesigned, and its staff provided new research project details. Changes to the remaining field station pages are in progress. New research descriptions include predator depredations, the tranquilizer trap device, a passive index for monitoring coyote movements, and zinc phosphide use by WS. All 400 individual species chapters in the Birds of North America series have been added to the NWRC online catalog. An employment Webpage has been added, and all NWRC job announcements are now posted on the Web. A Webpage was established for the planned August 2000 NWRC-sponsored "Human Conflicts with Wildlife: Economic Considerations" symposium, and a new timeline history of NWRC has replaced the former descriptive history page. Optical character recognition software is being tested for scanning older NWRC publication lists for placement on the Web and a search engine will be added for keyword searching of publication lists.

The NWRC library staff frequently responds to information and reference questions coming to the Center via the Web. Questions relating directly to work done at NWRC are immediately answered by library personnel; other questions may be referred to appropriate outside agencies and individuals. Inquiries have covered such diverse topics as wildlife rehabilitation, wildlife diseases, dolphin killing by fishermen, construction of outdoor water structures, identification of poisonous snakes, employment in the wildlife biology field, wildlife importation rules, and bird banding.

The NWRC library worked with the WS Operational Support Staff to provide Internet access for the Wildlife Worldwide data base. This product was tested by WS personnel and was considered extremely useful. In 1999, passwords were purchased to provide access to the data base for WS staff in all States. The library also purchased Graphical Library Automation System (EOS, Inc.) software to permit upgrading the Center's catalog, serials, and circulation modules from DOS to Windows. Desktop access to library CD–ROM's was provided to all Fort Collins staff. Subscriptions to Current Contents on Diskette and in paper copy were replaced by desktop Internet access. Four new journal subscriptions were added, and the library is studying the usefulness of electronic access to selected periodicals.

Library personnel have provided extensive background documentation in support of WS Environmental Assessments and Center research projects. More than 200 literature searches were performed. Search topics included chemical repellants, chemical identification and source location, control of exotic or invading species, control methods for various pest species, and citation verifications. The Internet was used to an ever greater degree in the information-gathering process and its resources now regularly supplement more standard online information sources. More than 1,600 photocopies were made from journals and books in the NWRC library for distribution to requestors. In addition, NWRC was better able to use the CSU library resources because their collection has been restocked since being damaged in the 1997 Fort Collins flood. This year NWRC library staff made more than 815 photocopies of materials at CSU. More than 2,250 NWRC-authored reprints were distributed as well as more than 500 copies each of the Center's annual publications list, highlights report, and newsletter. Other libraries requested 339 photocopies and books from the NWRC, and the NWRC Library, in return, requested at least 853 items from other libraries.

Worldwide Rodent Bibliography—A cooperative endeavor between NWRC and the Danish Pest Infestation Laboratory has been initiated to compile a worldwide rodent bibliography. This bibliography will combine more than 14,000 references maintained by the Danish lab and 9,000 maintained by NWRC on rodent ecology, biology, behavior, zoonoses, taxonomy, control, and epidemiology. A searchable data base will be assembled at NWRC and made available on a CD–Rom. Possibilities for access and use of this data base via the NWRC Webpage are being explored.

Living With Wildlife Activity Sheets— The WS Public Outreach Committee produced nine activity sheets for fifth- and sixth-grade children in 1999. Subjects include beaver, coyote, cougar, BTS, Canada goose, raccoon, deer, blackbird, wildlife research, and a national reader. Each activity sheet has information on the biology and food habits of the animal, legends and folklore, economic and damage issues, and a crossword puzzle. The sheets are available in PDF format on the NWRC Website at http://www.aphis.usda.gov/ws/nwrc.

Information Displays—NWRC staff worked with APHIS' Legislative and Public Affairs and USDA Design Division staff to create and install hallway displays in the main lobby area of the new Wildlife Science Building. The displays welcome visitors to the Center and describe its history, research accomplishments, and successful tools created by NWRC researchers. Additionally, more than 60 scientific and information posters illustrating current research projects have been installed in the hallways. The posters have served as an excellent source of information on NWRC research for individual visitors and tour groups.

Conference Services—NWRC's Wildlife Science Building includes a conference center with state-of-the-art audio visual technology. Numerous groups from local State and Federal agencies have made use of the facility for training, meetings, and seminars this past year.

SEMINARS

During FY 1999, NWRC continued to be a focal point for interesting seminars by its own and visiting scientists.

NWRC SEMINARS

Speaker	Affiliation	Topic
James Pfister	USDA–Agricultural Research Service Poisonous Plant Research Laboratory, Logan, UT	Impacts of plant toxins on foraging behavior and nutrition of herbivores
Roger Sayre	APHIS Science Fellow, NWRC	Bighorn sheep behavior: response to human disturbance
David Morris	Texas A. & M. University	Synchronizing ovulation in beef cattle
Paul Nash	University of Colorado Health Sciences Center, Dept. of Immunology	Immune response to *T. gondii* after primary and secondary infection and inhibition of apoptosis by *T. gondii* infection
David Jasko	Cornell University	Reproduction in managed horses and strategies for control in feral horses
Scott Hygnstrom	University of Nebraska–Lincoln	Science is "Deer" to me—Study results and sabbatical aspirations
Ann Kitchen	Utah State University	Resource partitioning between swift foxes and coyotes
Matthew Coles and Heather Kullas	Colorado State University	Surveillance for pathogenic bacteria from urban Canada goose populations
Gary White	Colorado State University	Designing control-treatment experiments with marked animals using program MARK
Lynn Creekmore	National Wildlife Health Center, Madison, WI	Cause of mortality in southern sea otters
Terry Hensley	APHIS, VS	Foreign animal diseases
Charlotte Quist	University of Georgia	The trap study, lesions produced by leghold traps
Roger Few	NWRC, APHIS Science Fellow	Enhancing the efficacy of primary repellants

MEETINGS, WORKSHOPS, AND CONFERENCE PRESENTATIONS

Bird Strike Committee–USA—Bird Strike Committee–USA (BSC–USA) was founded in 1991 to increase communication and professionalism among the diverse groups dealing with the economic and safety issues related to aircraft collisions with birds. Until BSC–USA was founded, there was no forum in the United States for training, scientific papers, vendor displays, and general discussions regarding the management of wildlife hazards to aviation. BSC–USA has an eight-person steering committee consisting of two members each from USDA, FAA, DoD, and the aviation industry. Scientists from NWRC have played key roles in many aspects of the organization from the beginning, including organizing the scientific program at each of the seven annual conferences, 1992–98. Attendance at these annual conferences has grown from 12 people in 1991 to 312 in 1998. In addition to the scientific programs, highlights of annual conferences in recent years have included keynote speeches by national political and aviation leaders, demonstrations during field trips of various techniques for managing wildlife at airports, and vendor exhibits of wildlife management products. In 1999, BSC–USA combined with Bird Strike Committee Canada and aviation officials from Mexico to hold the first Bird Strike Committee North America meeting in May at Vancouver International Airport in British Columbia. BSC–USA has played a key role in elevating awareness within the aviation industry to research and management expertise within USDA's Wildlife Services program.

CSU Carnivore Issues Course—A senior wildlife seminar during the fall 1998 semester, a capstone course for CSU students about to graduate from the Department of Fishery and Wildlife Biology, was taught by an NWRC research biologist. Using an informal format, the biologist and students discussed the history and current status of carnivores, carnivore ecology and management, human–carnivore conflict resolution, research needs, and carnivore reintroductions. Discussions were based on selected readings and the combined experiences of the biologist and the students. Each student was required to make an individual presentation, lead a topical discussion, or submit a term paper. The course was further enhanced by guest speakers and wildlife videos.

International Conference on Rodent Biology and Management—Two NWRC scientists participated in the International Conference on Rodent Biology and Management held in Beijing, China, October 5–9, 1998. More than 140 representatives from 26 countries attended the conference. Papers and workshops covered developments in the fields of rodent behavior, chemical communication, population dynamics, physiology and adaptation of rodents, rodents as indicators of environmental change and their role in maintenance of the ecosystem, epidemiology of rodent diseases and their impact on rodent populations and humans, and rodent management and control techniques. NWRC scientists presented a plenary talk on the current status of rodent management in the United States and two other presentations on current trends in rodent damage management for Hawaiian agriculture and conservation and impact of rodents on reforestation in the United States. One NWRC scientist also chaired a workshop and discussion session on rodent damage management. The discussion focused on improving communication among biologists working to reduce rodent associated problems, assessing the intensity or extent of damage, and monitoring rodent populations.

Ohio State University Student Field Day—The NWRC's Sandusky field station and the Ohio WS program hosted 22 graduate and undergraduate wildlife biology students from The Ohio State University at the 6,000-acre Plum Brook Station in early October. Students were given hands-on instruction in the scientific method by collecting data to estimate the size and dynamics of a deer population. Emphasis was placed on emerging conflicts between wildlife and people and the integrated research and management programs needed to resolve these conflicts. This is the 14th year that the Ohio field station has hosted these field exercises to educate natural resource students about the importance of wildlife damage control as a key component of the wildlife profession.

BTS Seminar—A WS operations staff member from Guam and an NWRC researcher from Fort Collins cooperated in presenting a seminar on BTS control and research work activities on Guam to the environmental biology class at the University of Guam on November 5, 1998. Operational snake control activities discussed included trapping, detector dog teams for searching outbound cargo, spotlight searching of fences, temporary barriers, and public relations programs to inform people about the environmental, economic, and safety and health concerns associated with snakes. Research and development of chemical fumigants and oral and dermal toxicants as well as their potential

use in an integrated program with other control techniques to reduce populations of snakes were discussed. The seminar concluded with demonstrations of snake handling and dosing techniques, presentation of videocassettes showing behavior of snakes at lure stations in the field, and a question-and-answer session about snake control and research activities.

Consortium for International Crop Protection Annual Meeting—An NWRC scientist from Fort Collins attended the Annual Board Meeting of the Consortium for International Crop Protection (CICP) in Las Vegas, NV, in November 1998. The CICP board has representatives from 11 U.S. universities and the USDA. The mission of CICP is similar to that of APHIS but focuses on developing countries: increasing supplies of nutritious and safe foods by reducing the losses caused by pests in ways that are appropriate for local economies and sociological and environmental situations and that encourage integrated pest management (IPM) and appropriate new technologies. CICP provides IPM information over the Internet www.ipmnet.org and supports workshops and conferences that disseminate information and develop communication linkages. A data base of IPM resources is maintained at OSU. The board assessed the successful workshop in Africa and planned similar efforts for Latin America and Eastern Europe. The success of IPMnet News, an e-mailed newsletter, was discussed along with ways to bring in larger CICP membership and donor funding.

Vertebrate Pests of Agriculture, Forestry, and Public Lands Western Coordinating Committee (WCC)—Also during November, several NWRC biologists attended the annual meeting of WCC–95 in Reno, NV. This group, which is sanctioned through the USDA agricultural extension program, consists of about 40 participants from academia, industry (chemical registrants), and Federal and State governments who make up the Western Coordinating Committee of Vertebrate Pests of Agriculture, Forestry, and Public Lands. The group attempts to foster communication, research, and extension activities affecting vertebrate pest issues in 13 Western States. Some key discussions at this year's meeting focused around stakeholder responses to recent RED's released by EPA for registered end-product pesticides; effects of California's Proposition 4 (ban on leghold traps, sodium cyanide, and sodium monofluoroacetate [Compound 1080] for management of mammalian predators); approval of a new 5-year petition to continue the group's activities, research, chemical registration, and public policy; and consideration of forming a similar committee to address wildlife and resource-management issues affecting Northeastern States.

Predator Management Board—An NWRC scientist from the Logan, UT, field station presented a talk on NWRC predation management activities to the Predator Management Board in Durango, CO, in December 1998. Ongoing research and the need to maintain and improve existing tools were discussed. The board meeting was attended by ranchers, Government officials, and representatives from various interest groups, including the Audubon Society. The talk was well received, and the Audubon Society requested NWRC scientists to present additional information to a larger forum in 2000.

Utah Woolgrowers and Cattlemen's Association—An NWRC scientist from the Logan, UT, field station presented a talk on coyote ecology at the annual meeting of the Utah Woolgrowers and Cattlemen's Association in December 1998. Biology and predatory behavior of coyotes were discussed in the context of how ranchers can work with WS specialists to take coyotes responsible for depredation selectively.

U.S. Department of Defense Meeting—In February 1999, the NWRC hosted the Annual Review of USDA Research of Interest to the U.S. Department of Defense. USDA research was presented by scientists representing the Forest Service, Agricultural Research Service, and NWRC. Center participants focused on wildlife issues related to chemical repellants, reproductive inhibitors, integrated pest management, bird–aircraft interactions, chemical registration, and BTS control. About 80 individuals from USDA, DoD, CDC, and the U.S. Geological Survey attended this first-ever symposium at the NWRC Wildlife Science Building in Fort Collins.

Pacific Seabird Group 26th Annual Meeting—A biologist from NWRC's Starkville, MS, field station attended the 26th Annual Meeting of the Pacific Seabird Group in February at Blaine, WA. The biologist presented a paper on movements of American white pelicans banded at Marsh Lake, MN, with emphasis on their relationship to aquaculture in the Southeast. Before 1985 and the expansion of Southeastern aquaculture, only 5 percent of pelican band recoveries were from areas of high aquaculture production. Since 1985, more than 21 percent of the band recoveries have been from aquaculture areas, suggesting that commercially raised fish are an important food source for wintering and migrating American white pelicans. The biologist also participated in a research and information needs workshop for the North American Colonial Waterbird Conservation Plan. This plan will provide a blueprint of the research, monitoring, management, and public outreach needs of colonial waterbirds throughout North America.

NWRC Hosts Veterinary Services' Emerging Diseases Workshop—A special planning session of APHIS' Veterinary Services (VS) was held in Fort Collins in March to discuss emerging wildlife–livestock disease issues. The meeting was facilitated by APHIS' Policy and Program Development personnel. The session was also attended by personnel of VS' Centers for Epidemiology and Animal Health, the Southeastern Cooperative Wildlife Disease Unit, and an NWRC research biologist. Wildlife has been linked to recent outbreaks and the spread of chronic wasting disease, bovine tuberculosis, brucellosis, rabies, and other diseases. VS personnel are prepared to deal with these diseases in livestock but not necessarily in wildlife. The group agreed that VS needs to focus its efforts on (1) disease investigation, (2) disease monitoring and surveillance, (3) applied research, (4) training and information transfer, and (5) appropriate regulations. Action items identified were to (1) increase funds to process the many wildlife samples submitted each year, (2) enhance communication and information networks between VS and other appropriate entities, and (3) train VS personnel in various aspects of wildlife identification, monitoring, handling, and processing. Increased wild game farming and the extensive market in exotic wildlife make the success of these efforts even more urgent.

Managing for Biodiversity Conference—Between March 30 and April 2, personnel from the NWRC's Gainesville, FL, field station attended the joint spring conference of the Florida Wildlife Society and Natural Areas Association entitled "Managing for Biodiversity" held in Orlando. More than 150 people were in attendance, including wildlife biologists and ecologists from the private sector, and State and Federal wildlife management agencies. Topics covered included wildlife conservation and management, ecological restoration, prescribed burning, and ecotourism. NWRC staff presented results from studies that evaluated relocation as a management tool for vultures and wading bird depredation at tropical aquaculture facilities. Florida NWRC staff maintain a longstanding tradition of membership and involvement in the Florida Wildlife Society. This association has been of value in maintaining lines of communication with Federal and State wildlife managers and regulators and in fostering alliances that facilitate wildlife research and management in the State.

Catfish Research and Industry Update Forum—A biologist from NWRC's Starkville, MS, field station participated in a catfish research and industry update forum in March, sponsored by the Alabama Catfish Producers and the Alabama Fish Farming Center. The biologist highlighted the mission of the Starkville field station and its cooperative work with the Alabama WS program on a cormorant roost-dispersal effort. More than 150 people attended the forum.

Swift Fox Seminar—On March 15, a Utah State University graduate student working with NWRC biologists at the Logan, UT, field station, presented a seminar on resource partitioning between swift foxes and coyotes at NWRC in Fort Collins. This student investigated the spatial, temporal, and dietary overlap between swift foxes and coyotes and found a high degree of interspecies overlap in all factors. However, even with a spatial overlap, foxes did not temporally avoid coyotes. Some dietary partitioning occurred between the two species, for coyotes tended to consume larger mammalian prey species whereas swift foxes tended to consume smaller prey species. The main strategies used by swift foxes that allow for coexistence with coyotes were year 'round use of dens and some degree of dietary partitioning.

Utah State University Career Fair—A biologist from NWRC's Logan field station participated in Utah State University's Annual Career Fair in March. She supplied materials about APHIS to interested students and answered their questions about careers available in APHIS for graduates with various majors. Over the last 4 years, both Plant Protection and Quarantine and WS personnel have worked together at the booth. This association has proved useful in broadening the relationship between these APHIS programs as potential employers of Utah State University students.

Lake Erie Wing Watch Weekend—Scientists from NWRC's Sandusky field station staffed a display booth promoting NWRC research findings and the WS program on April 10 at the Lake Erie Wing Watch Weekend. This is an annual event sponsored by the Visitors Bureaus and Audubon Society chapters from three northern Ohio counties that is designed to educate the public regarding the importance of bird watching and wildlife refuges to the tourism economy of northern Ohio. The western basin of Lake Erie is a critical migratory corridor for waterfowl, shorebirds, and neotropical migrants in North America. The theme of the NWRC display, resolving conflicts between people and wildlife, emphasized wildlife damage management as an integral part of conservation programs designed to protect and enhance bird populations. Ohio has large populations of blackbirds, starlings, gulls, Canada geese, cormorants and herons—species that often conflict with human activities. More than 500 people attended the program, and the NWRC display generated much positive interest and many questions. NWRC has participated in this program annually since its inception in 1993.

Northeastern Association of Wildlife Damage Biologists—An NWRC scientist with the Logan field station attended the eighth annual meeting of the Northeastern Association of Wildlife Damage Biologists in Manchester, NH, in April. The Association now has a Website that presents its newsletter and provides links to other damage management Websites in the Northeast. The 1999 meeting covered the status of deer damage-management laws in the Northeast and the establishment and funding of a northeastern wildlife damage management cooperative to serve the needs of the 13 Northeastern States.

Red Wolf Program Review—Biologists from NWRC's Logan field station attended the Red Wolf Program review in Virginia Beach, VA, in April. More than 40 researchers, managers, and administrators were assembled to participate in this workshop whose purpose was to develop a plan for the continued recovery of the red wolf. Issues and programs addressed included captive breeding, site selection, canid management, hybridization, modeling, and monitoring of red wolves in the free-ranging population. It was the consensus of all participants that hybridization of red wolves and coyotes is an immediate concern and that management actions are necessary to reduce its occurrence.

International Seminar on Flight Safety and Birds in the Middle East—A biologist from NWRC's Sandusky field station was an invited participant in the International Seminar on Flight Safety and Birds in the Middle East in Tel Aviv, Israel, in April. He presented a seminar on aerodrome bird hazard prevention and discussed a case study at John F. Kennedy International Airport that compared the results of shooting and falconry in reducing bird strikes. The study indicated that shooting gulls reduced strikes by 80 percent from 1991 through 1998. The addition of falconry to the bird control program in 1996 through 1998 generated considerable positive publicity but has not further reduced strikes. The presentation was featured in an article in Ha 'aretz, the major daily newspaper in Israel. The seminar, organized by Tel Aviv University, was designed to increase cooperation among countries in the Middle East in reducing bird strikes and to further the peace process in the region. Participants included air force officers from Israel, Jordon, Turkey, Greece, and the United States. Mr. Shimon Peres, former Israeli prime minister, was a featured guest at the meeting.

Association for Chemosensory Sciences Meeting—NWRC biologists from Fort Collins attended the annual meeting of the Association for Chemosensory Sciences in Sarasota, FL, in April. The Association is devoted to the study of how animals and humans detect, process, and act upon chemosensory information. One biologist served on this year's scientific program committee. Three posters were presented by NWRC scientists on the topics of preferences of European starlings for mixtures of natural plant products; development of cell culture methodology to screen trigeminally mediated chemical repellants; and the effects of capsaicin, denatonium, and Vexar™ plastic mesh plant protectors as chemical and physical repellants on gnawing behavior of wild Norway rats.

Worldwide Airport Technology Conference and Exposition—Two biologists from NWRC's Sandusky field station presented results from research on wildlife hazards to aviation at the 1999 Worldwide Airport Technology Conference and Exposition in Atlantic City, NJ, in April. The conference was attended by representatives from throughout the aviation industry. The keynote address by James Hall, chair of the National Transportation Safety Board, highlighted bird strikes as a key safety issue facing the aviation industry. Topics covered by the NWRC scientists included the development and registration of an anthraquinone formulation to repel geese from airports and the use of Forward Looking Infrared equipment to monitor deer populations and wildlife activity at airports.

Bird Strike Committee–USA and Canada Joint Meeting—About 300 people from 14 countries attended the first combined annual meeting of Bird Strike Committee–USA (BSC–USA) and Bird Strike Committee Canada (BSCC) at Vancouver International Airport, British Columbia, between May 9 and 13, 1999. In all, 47 technical papers and posters were presented on topics related to reducing wildlife collisions with aircraft. NWRC scientists presented papers and posters on grass management at airports and on the National Bird Strike Database. Highlights of the conference included keynote addresses by Major General Francis Gideon, Jr., head of the U.S. Air Force Safety Agency; John Kern, vice president for safety at Northwest Airlines; Art LaFlamme, director general of aviation at Transport Canada; and USDA Under Secretary Mike Dunn. In addition, 14 companies exhibited or demonstrated their wildlife management products during a tour of the Vancouver airport. The goal of BSC–USA and BSCC is to increase communication and professionalism among the diverse groups dealing with wildlife issues at airports. The next joint meeting of BSC–USA and BSCC will be August 8–10, 2000, at Minneapolis–St. Paul International Airport.

Wildlife Strikes to Civil Aircraft—Biologists from NWRC's Sandusky field station, in cooperation with the FAA, have completed a summary of all wildlife strikes to civil aircraft in the United States between 1991 and 1997. During this 7-year period, there were 16,949 reported strikes, of which about 97 percent involved birds and 3 percent mammals (mostly deer). The average cost per year to civil aviation from these strikes was estimated to be $315 million. The report contains detailed information on such strike

characteristics as species of wildlife, time of day, geographic area, altitude, time of year, and phase of flight. Information documenting the hazards of wildlife at airports is critical for developing and presenting wildlife plans for airports. This report can be found on the Internet and downloaded with the use of Adobe Acrobat Reader at www.faa.gov/arp/arphome. Once the user has found this page, select Browse by Topic and find Bird Strike Report.

Predator Experiences—In May, an NWRC biologist with the Logan–Millville field station presented a class on predators and herbivores to the Family Development Preschool. The class included 20 children ages 3–4 and 5 preschool teachers. Among the topics presented were the basic anatomical differences between predators and herbivores and a hands-on demonstration using animal skulls and skins and young goats to demonstrate precocial attributes of prey animals. In June, 19 people from an assisted living facility in Logan also visited this NWRC research facility. Station personnel described the history of the facility and explained its research program. A bus tour provided additional opportunities for the people to view adult coyotes, have a closeup experience with hand-reared coyote pups, and to discuss various aspects of the Center's predator research and its application to solving depredation problems.

Wildlife Services National Meeting—WS held a national meeting in May in Estes Park, CO. More than 170 participants from the eastern and western regions, headquarters, and NWRC attended. The theme for the conference was charting a course for the millennium through partnerships, politics, and science. Keynote speaker Dwight Guynn, FWS, spoke on wildlife professionals facing the future and the need for the profession to change and adapt to meet the new needs of the 21st century. Participants attended a variety of workshops on topics such as invasive species, deer damage and management techniques, Canada goose and blackbird problems, traps and lures, and public outreach. They also attended field trips on elk management in Rocky Mountain National Park, toured the NWRC and visited prairie dog colonies near Fort Collins.

Ecological Committee on FIFRA Risk Assessment Methods—An NWRC registration unit employee participated in a 1-year series of bimonthly meetings sponsored by the EPA to evaluate EPA's pesticide environmental risk assessment guidelines. The 48-member Ecological Committee on FIFRA Risk Assessment Methods was composed of representatives from EPA, USDA, Environment Canada, the American Crop Protection Association, pesticide manufacturers, nongovernment environmental organizations, academia, and environmental consultants. Workshop participants were asked to develop methods for determining the probability of an organism's exposure to pesticides and the subsequent effects of those pesticides. A draft report was issued by EPA in May 1999, and a final report should be available by spring 2000. Implementation of any proposed changes to existing methods would occur gradually as data bases are developed and the new methods are validated. Methodology was provided for conducting exposure and effects modeling and for combining the output from the exposure and effects model into a tiered risk characterization process. To standardize lower tier risk assessments, recommendations were made for selecting key species for use in standardized exposure and effects models. Additionally, recommendations were made for redesigning standard toxicity tests to make outputs more appropriate for use in probabilistic models.

Agriculture in the Classroom Summer Institute—NWRC hosted a visit from more than 20 elementary and middle school teachers in June as part of the USDA–Colorado Agriculture in the Classroom Program. Scientists gave an overview of NWRC's mission and research, and participants were given a tour of Center facilities.

Temperate Rice Conference—A biologist from NWRC's Gainesville, FL, field station attended the Second Temperate Rice Conference in June in Sacramento, CA. The biologist presented a talk on recent developments in the control of blackbird depredations in ripening rice. In addition to technical paper sessions, the conference included a special symposium on rice and the environment and a daylong field trip and tour of rice fields and research projects in the Sacramento Valley with particular emphasis on enhancement of rice field habitat for waterbirds. The conference was attended by more than 250 delegates from 12 temperate rice-producing countries. The third conference is scheduled to be held in 2003 in Uruguay.

Avian Mortality at Communication Towers—In July, a biologist from NWRC's Gainesville field station was an invited participant in a meeting convened by FWS in Washington, DC, that addressed the problem of avian mortality at communication towers. It is estimated that millions of neotropical migrant birds are killed annually through collisions at tall, lighted TV, radio, and communication towers. This phenomenon has been documented since the 1950's but has been subject to very little experimental research. Concern over tower kills has increased lately for two reasons: the continued declines in populations of many neotropical migrants, which are the birds most often killed at towers, and the proliferation of towers in recent years because of the wireless communication industry. The meeting also included representatives from the FAA, Federal Communications Commission, wireless communication companies, and environmental organizations, as well as research scientists. Discussions centered on defining what is known about the problem, identifying

information and research needs, and forging alliances of interested parties to address the identified research needs. A coordinating committee was formed to facilitate additional discussions among stakeholders to refine goals and establish research priorities.

Another workshop entitled "Avian Mortality at Communication Towers" was held in August as part of the 117th meeting of the American Ornithologists' Union at Ithaca, NY. This workshop, cosponsored by FWS, the American Bird Conservancy, and the Ornithological Council, was the first of its kind on the problem of avian mortality caused by collisions with cellular, radio, and TV towers. It was generally decided that research is needed to define the nature and extent of the mortality problem more completely and identify priority research areas that will lead to developing methods to reduce avian collision mortality.

Southeastern WS Meeting—Personnel from NWRC's Gainesville field station participated in a meeting of Florida, Alabama, and Georgia WS State directors and staff in August in Key Largo, FL. NWRC personnel presented summaries of recent and planned research in tropical aquaculture, tropical fruit damage, and vulture management. Training in first aid and cardiopulmonary resuscitation, defensive driving, firearm safety, and the use of AC was also provided. This was the first multi-State meeting hosted by the Florida State WS program, and it provided a good opportunity for WS personnel in the three-State area to exchange information and ideas.

Double-Crested Cormorant Management Meeting—Populations of double crested cormorants have increased dramatically over much of North America during the last 2 decades and today are a source of conflict on both their wintering and breeding grounds. Cormorants cause millions of dollars' worth of losses for commercial aquaculturists in the Southern United States, are a perceived threat to sport and commercial fishermen in the northern United States and Canada, and compete with other waterbirds for breeding sites. In 1998, FWS issued a new regulation approving the oiling of eggs of cormorants breeding on Little Galloo Island in Lake Ontario. An NWRC biologist attended a meeting in August in Sackets Harbor, NY, to discuss research and monitoring needs for managing double-crested cormorants in eastern Lake Ontario. The meeting was attended by 37 people from private, Government, and university organizations in Canada and the United States. A consensus was reached that more information is needed about regional movements to manage the impact of cormorants in eastern Lake Ontario; that a better understanding is needed of migratory movements, life history, and demography of cormorants; and that a credible population model is needed to manage cormorants on a flyway basis.

Northwest WS State Meeting—A biologist from the Sandusky field station represented NWRC at the WS State meeting for Washington, Alaska, Hawaii, and Guam at Ft. Worden State Park, WA, in July. He made a presentation on managing wildlife hazards on airports. This talk emphasized research being conducted by NWRC scientists (e.g., development of the National Wildlife Strike Database and the bird-feeding repellant Flight Control) that provides a scientific foundation for WS management programs at airports. Wildlife hazard management at airports is an increasingly important undertaking for the WS program. WS biologists provided assistance at 363 airports in the United States in 1999. The conference was attended by about 60 WS employees as well as by several Washington State biologists.

CSU Undergraduate Research and Creativity Symposium—Two CSU undergraduates, Heather Kullas and Matthew Coles, who are working under the direction of an NWRC biologist in Fort Collins, earned the Highest Distinction Award for their presentation on the survey, identification, and isolation of Escherichia coli and Salmonella spp. in Canada goose fecal matter at CSU's fifth annual Undergraduate Research and Creativity Symposium. The students' work is part of an independent research project through the Department of Fisheries and Wildlife Biology at CSU. Kullas and Coles are quantifying the relationship between specific zoonotic diseases and goose fecal load in urban landscapes within Fort Collins.

European Vertebrate Pest Predator Management Board—Three NWRC biologists attended the Second European Vertebrate Pest Management Conference in September in Braunschweig, Germany. More than 250 scientists from 25 different countries attended to discuss various aspects of vertebrate pest management. NWRC scientists organized and led symposia sessions on repellants as wildlife management tools and monitoring abundance of potential problem in wildlife species. The NWRC scientists made other presentations on nontarget impacts of strychnine baiting to reduce pocket gopher populations on forest lands in the United States, hormonal mechanisms of litter reduction under predator odor influence, black bear management to protect forest resources in Washington State, repellants as vertebrate pest management tools, a passive tracking index for monitoring wild canids and associated species, and integrated management tactics to assess risk and reduce damage to conifer reforestation by pocket gophers. Center posters addressed protecting lettuce from birds, reducing bird damage to aquaculture, and understanding the sensory biology of birds as related to chemical repellants.

University Seminars Presented on Indexing Animal Populations—An NWRC scientist has been developing methods to monitor population changes using passive track station surveys. He was invited to present seminars at two Colorado universities on this topic. In January, he gave presentations on this animal population at the University of Denver Health Sciences Center and at CSU. Resource managers need practical, efficient methods to accomplish the important task of monitoring pest populations before and after damage reduction activities. This passive tracking index may provide one such method.

Wildlife Society Conference—NWRC scientists and graduate students attended the Wildlife Society's 6th annual conference in Austin, TX, in September. The NWRC director and a research scientist made presentations in a symposium entitled "Improving Public Perception and Understanding of Wildlife Damage Management." Other NWRC scientists made six additional oral or poster presentations on research results relating to rodents, birds, and carnivores. The WS program also hosted a special symposium entitled "Bats and People: Conservation, Public Health, and Conflicts." All wildlife damage-management sessions were well attended. NWRC scientists also participated in the Wildlife Society's Wildlife Damage Management Working Group and a student mentoring session. About 1,400 people attended the conference.

11th Triennial International Biodeterioration and Biodegradation Symposium—The 11th International Biodeterioration and Biodegration Symposium was held in Arlington, VA, in August. Twenty different sessions on such topics as deterioration of wood construction materials, cultural property, consumer products, biomedical devices, and impacts of vertebrate pests attracted more than 300 participants. NWRC sponsored and cohosted with Bowling Green [OH] State University a special session on future technology for managing overabundant wildlife. Presentations focused on human–wildlife conflicts involving commensal and agricultural rodents and ungulates and on management techniques such as frightening devices, repellants, rodenticides, fumigants, fertility agents, and IPM approaches. Scientists from India and Pakistan also participated in this special session.

Wildlife Hazards Workshop—An NWRC scientist from the Sandusky field station presented an invited lecture on research findings on repellants, grass height management, and new technologies for reducing wildlife hazards to aviation at a Wildlife Hazards Workshop in August at Kansas City International Airport. About 100 airport operations personnel attended the workshop, which was sponsored by the American Association of Airport Executives. The presentation emphasized the complexity of wildlife management at airports and the necessity of planning and implementing professionally developed, science-based wildlife hazard management plans. The talk also emphasized needed research in the areas of vegetation management at airports to reduce bird activity. Presently there is much confusion over grass types and grass heights that are optimum to reduce overall bird activity for gulls, geese, and other species of concern at airports. The NWRC Ohio field station, under an interagency agreement with the FAA, is conducting multiyear vegetation studies in Ohio, New York, and Washington to better define vegetation management regimes that will minimize hazardous wildlife on airports. Wildlife strikes cost the civil aviation industry more than $300 million/year in the United States.

Kansas Blackbird Damage Management Seminar—A scientist from NWRC's Bismarck, ND, field station presented a seminar on blackbird damage management to the Kansas Farm Bureau in Manhattan, KS, in August. Attendees included feedlot operators, agricultural producers, and personnel from State and Federal agencies. Feedlot operators and agricultural producers incur extensive economic damage from 10 to 20 million blackbirds that roost in dense stands of cattail. Information was provided on potential methods of reducing blackbird damage, including the use of an aquatic herbicide to reduce roosting habitat. NWRC scientists plan to study the regional movements of this blackbird population in relation to sunflower and feedlot damage.

Tropical Fruit Damage by Birds—In south Florida, the tropical fruit industry is becoming increasingly important. Growers are annually harvesting more than 2.25 million pounds of litchis and longans, a related pulpy fruit, valued in excess of $4.5 million. Bird damage is becoming an important constraint to production for many tropical fruit growers. Common grackles appear to be the most serious pest species, but monk parakeets also cause significant damage, especially when they nest near an orchard. Biologists from NWRC's Gainesville field station conducted a preliminary trial to quantify the extent of bird damage to longans in three south Florida orchards. Estimates of fruit loss to birds in these three orchards ranged from 9 percent to 89 percent.

Also, an NWRC Gainesville field station biologist and University of Florida graduate student working with NWRC presented information regarding longan and litchi fruit damage by monk parakeets and grackles to a group of more than 100 tropical fruit farmers at a workshop on longan and litchi fruit production at the University of Florida's Tropical Research and Education Center in Homestead, FL, in August. The results from the preliminary damage assessment trial will be used to develop a cooperative program between the Center, NWRC, and Florida tropical fruit growers to formulate solutions to this bird damage problem.

United Nations Conference of the Directors General of Civil Aviation—A biologist at NWRC's Sandusky field station has written a technical paper for FAA entitled "Research and Management Programs To Reduce Wildlife Hazards at Civil Airports in the United States of America." This paper was presented by FAA officials at a United Nations conference of the directors general of civil aviation in Hanoi, Vietnam, in September 1999. The paper reviewed research and operational assistance that the WS program has provided to the FAA in reducing wildlife hazards to aviation. Since 1991, NWRC has also assisted the FAA with the development of a Wildlife Control Manual for Airport Operators, which was published in January 2000. These research activities support FAA policy regarding wildlife hazards and assist airports in complying with FAA regulations (14 CFR 139.337). In addition to the research activities, WS biologists, through a Memorandum of Understanding with the FAA, provided operational or technical assistance at 192 airports in 1998 to reduce wildlife hazards to aviation. The FAA–USDA partnership provides an outstanding model of cooperation and efficiency between Federal agencies to improve aviation safety.

USDA Under Secretary Dunn's Visit to Ohio—Michael V. Dunn, USDA's Under Secretary for Marketing and Regulatory Programs, visited the Sandusky field station on September 3, 1999. Dunn was provided an overview of research on wildlife–human conflicts being conducted by the NWRC Ohio field station. Most research at this station relates to developing technologies to reduce bird–aircraft collisions and blackbird damage to agriculture. Dunn was shown experiments involving lasers to disperse birds, vegetation management to discourage birds from landing on airfields and food waste composting to reduce gull populations at landfills. Station personnel also provided a demonstration of the National Wildlife Strike Database that NWRC manages for the FAA. Dunn also visited a local farm, where he observed an experimental use of helium filled balloon kites as part of an integrated management program to frighten redwinged blackbirds from sweet corn plantings. Blackbirds continue to have major impacts on corn in Ohio.

Colorado State University Career Fair—NWRC participated in the CSU Career Fair in September. A display highlighting research activities and brochures and pamphlets about WS and NWRC attracted many people and generated great interest in NWRC's research program. The purpose of the career fair was to provide an informal setting for students to learn more about career options and opportunities within State and Federal agencies and private industry.

Summer Winter Integrated Field Technologies (SWIFT) Conference—A biologist from NWRC's Sandusky field station presented an invited paper entitled "Does Tall Grass Reduce Bird Numbers on Airports?" at the SWIFT Conference held in September in Calgary, AB, Canada. The SWIFT conference is an annual gathering at which airport operators and maintenance personnel exchange technical information on the safe and efficient operation of airfields. The concern over bird numbers attracted by different grass heights relates to safe airport operations and the risk of bird–aircraft collisions (bird strikes). Under an interagency agreement with the FAA, NWRC is conducting multiyear vegetation studies in Ohio, New York, and Washington to better define vegetation management regimes that will reduce attraction of hazardous wildlife on airports. Bird strikes cost civil and military aviation $300 million annually in the United States and pose a safety hazard to flight crews and passengers. The conference was attended by more than 400 air travel industry professionals.

Avian Effects Assessment Workshop—Two NWRC scientists participated in an international workshop on avian effects assessment in September in Woudschoten, the Netherlands. The workshop was sponsored by the Society for Environmental Toxicology and Chemistry, the Organization for Economic Cooperation and Development, and the European Union. The 45 workshop participants reviewed a draft framework document for assessing the effects of pesticides on birds. In small working groups, participants applied the draft framework to specific case studies involving insecticidal seed treatments, fungicides, granular and foliar insecticides, rodenticides, and other types of chemicals. The resulting document will be the basis for a set of common testing standards to assess the effects of pesticidal chemicals on birds.

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[**Boldface type** indicates that an author is employed at NWRC.]

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